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Sharrah et al.

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(54) **PORTABLE LIGHT HAVING A HEAT DISSIPATER WITH AN INTEGRAL COOLING DEVICE**

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F21V 29/02 (2006.01)
F21L 4/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC . ***F21V 29/02*** (2013.01); ***F21L 4/00*** (2013.01); ***F21V 29/71*** (2015.01); ***F21V 29/74*** (2015.01); *F21Y 2101/02* (2013.01)

(58) **Field of Classification Search**
CPC ... F21V 21/084; F21V 29/02; F21Y 2101/02; F21Y 2103/003; F21Y 2113/005; G02B 6/0008; G02B 6/4298; G03B 29/00; F21L 4/00; F21S 4/008; A61B 18/18; A61B 17/320068; A61B 18/1492; A61N 5/00; A61M 5/1723; A61M 5/172; B01L 3/502707
USPC 362/373, 158, 477, 183, 307, 235, 345, 362/208, 294, 206, 188, 202, 203, 119, 205, 362/396, 390, 485, 236, 198, 194, 800, 362/249.04, 218, 555, 362, 157, 184, 219, 362/225, 227, 231, 23.07, 23.19, 311.02; 313/44–46; 703/6; 716/108; 600/178, 600/245, 199, 249; 606/30; 607/88; 222/394, 395; 1/171.3; 345/905
See application file for complete search history.

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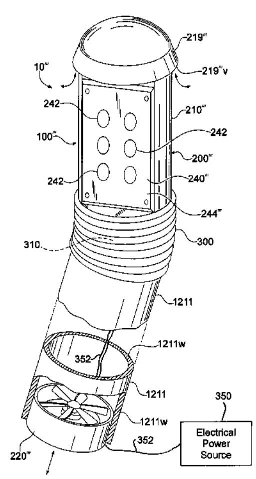
(57) **ABSTRACT**

A portable light or device or heat dissipater may comprise a heat sink for having a light source or other heat generating element thermally coupled thereto, and having a plurality of walls extending from a side thereof for defining a cavity and plural passages, a fluid mover in the cavity of the heat sink for selectively causing a fluid to move through the cavity and the plural passages, and a light source or other heat generating element adjacent to and thermally coupled to the heat sink. The heat dissipater may be connected to a housing in various configurations.

20 Claims, 9 Drawing Sheets



(51) **Int. Cl.**

F21V 29/71	(2015.01)
F21V 29/74	(2015.01)
F21Y 101/02	(2006.01)

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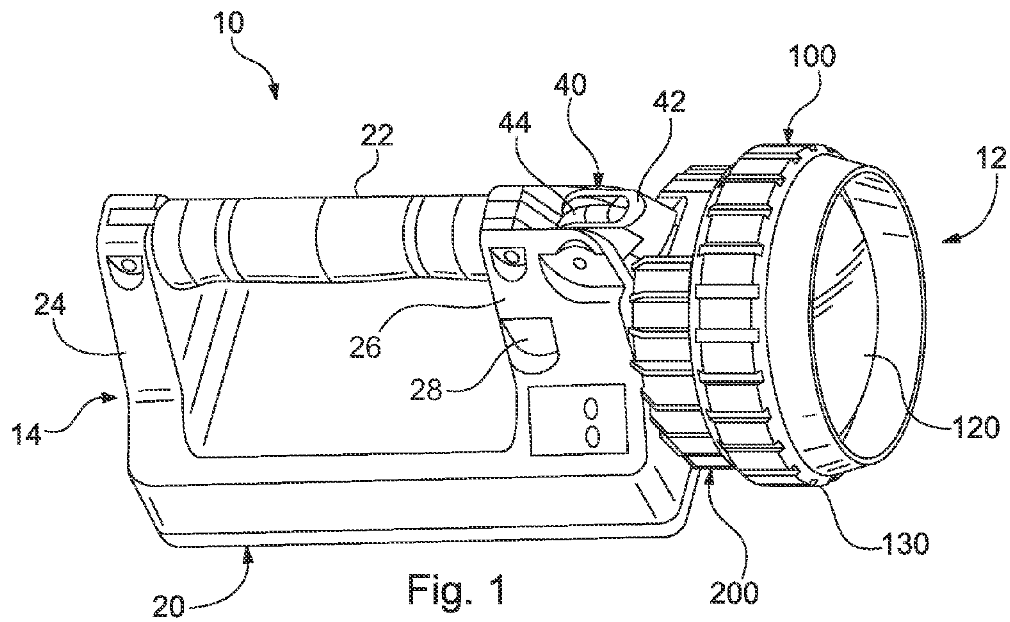

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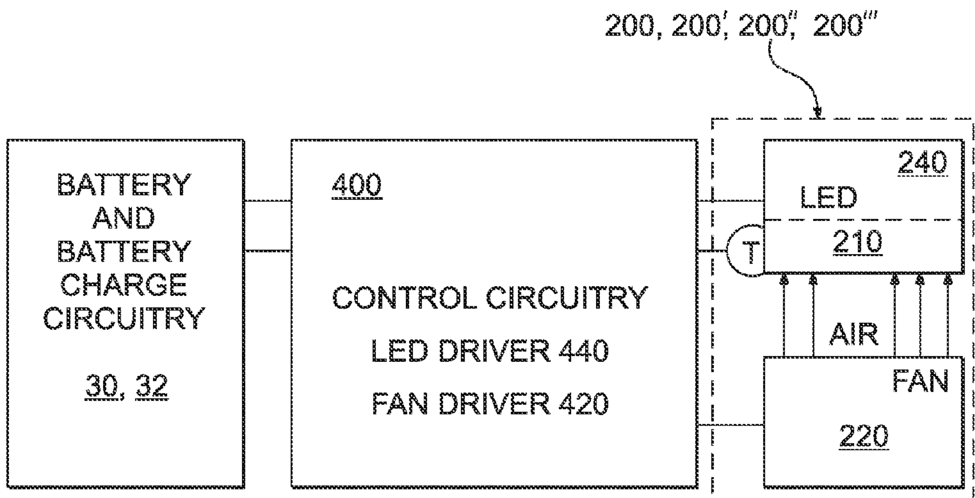
Fig. 1



200, 200′, 200″, 200‴
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CONTROL CIRCUITRY
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FAN DRIVER 420
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Fig. 9

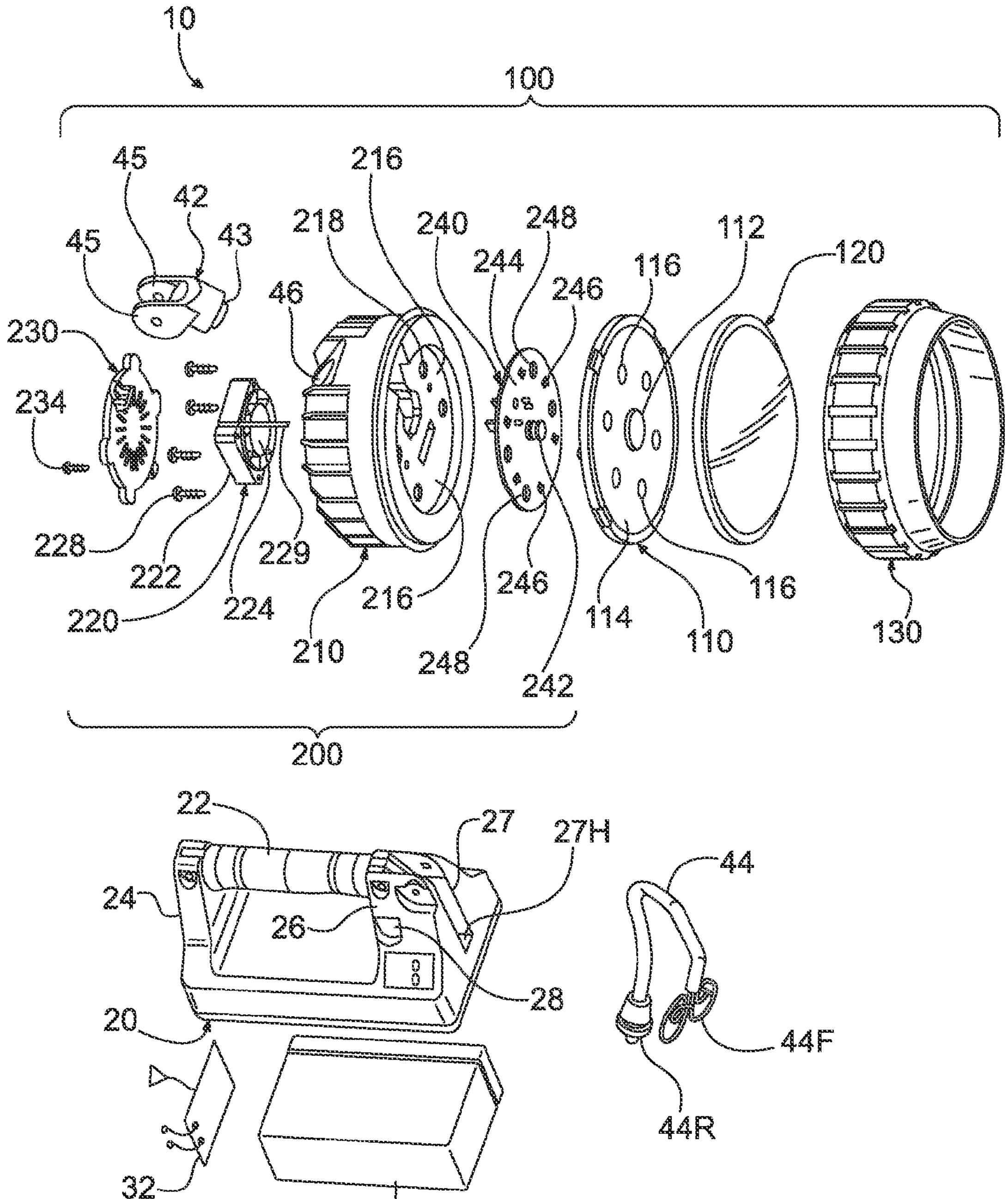
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Fig. 2

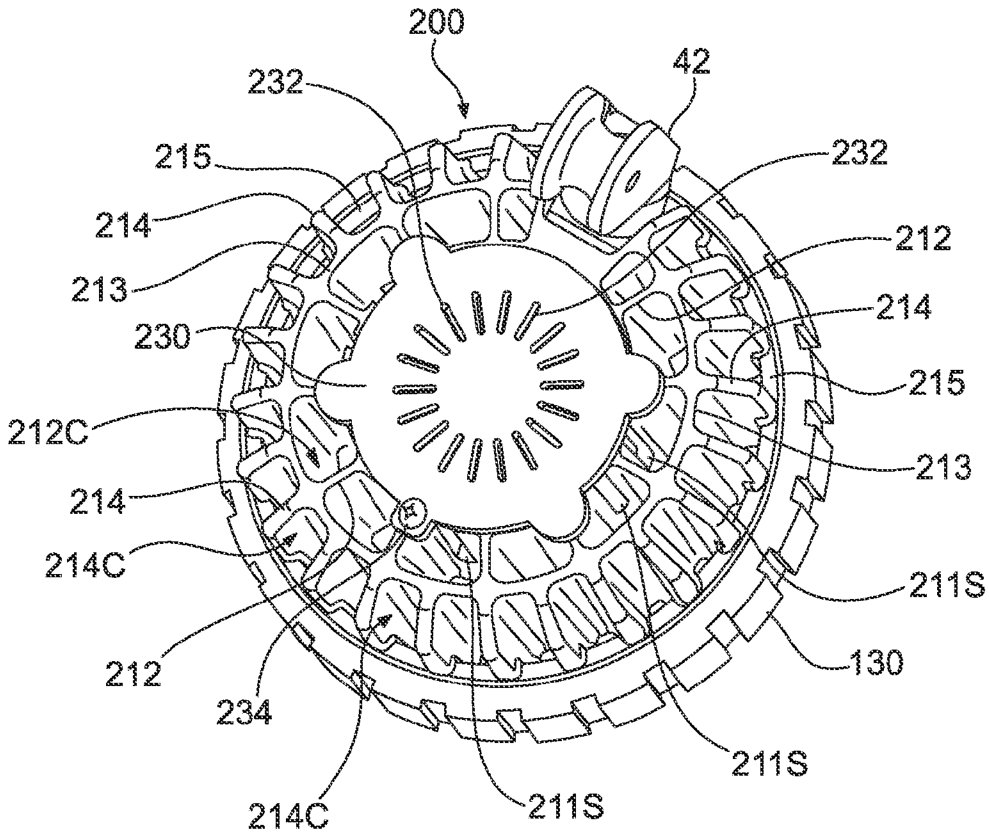
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Fig. 3A

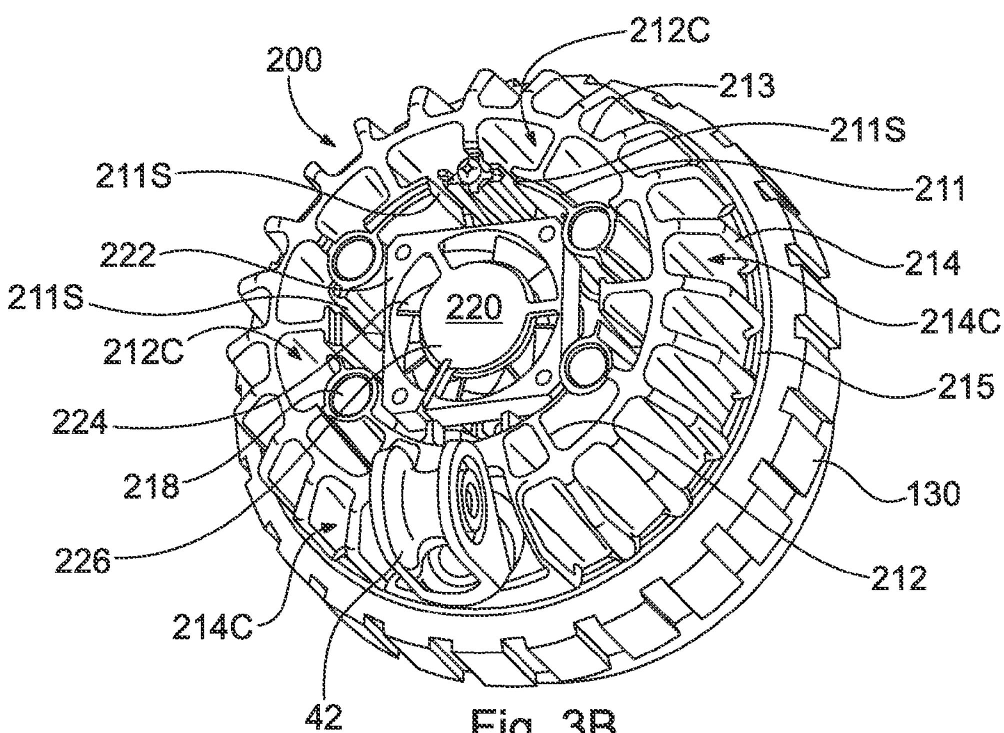
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Fig. 3B

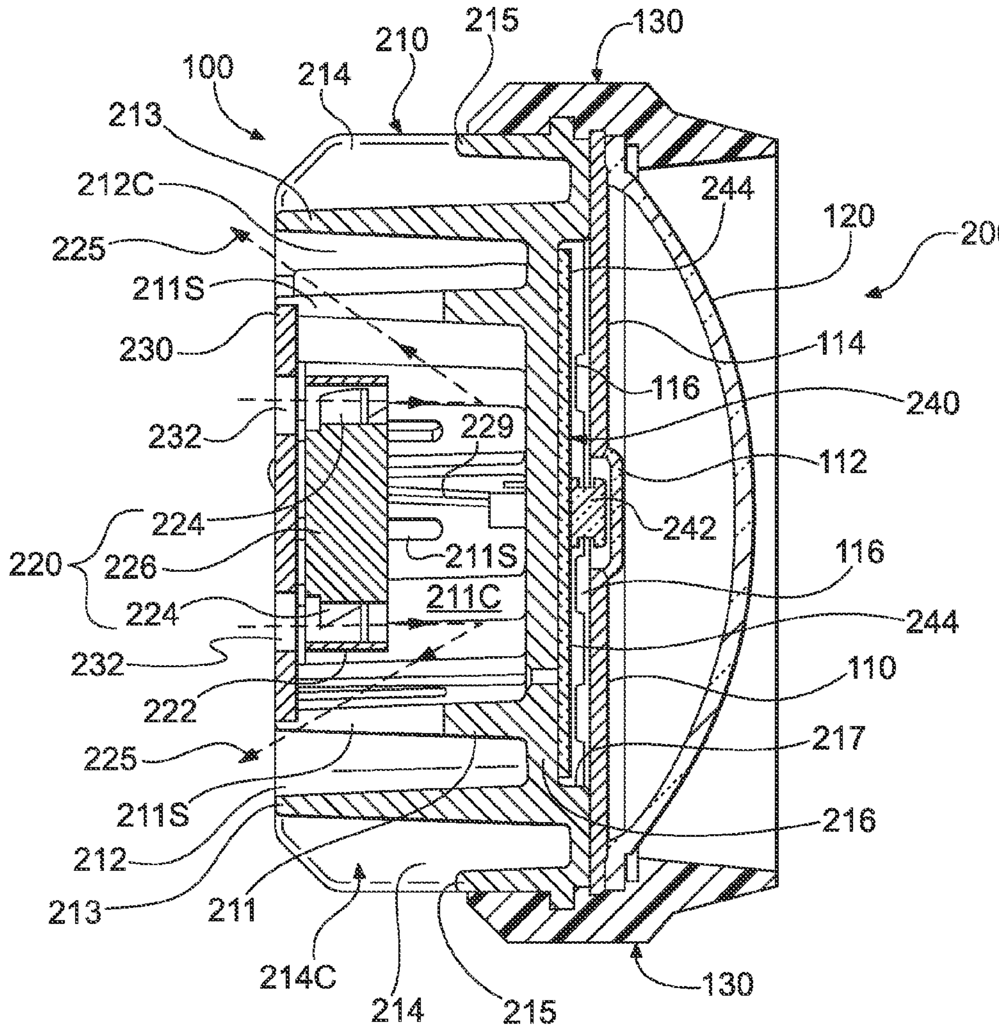
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Fig. 3C

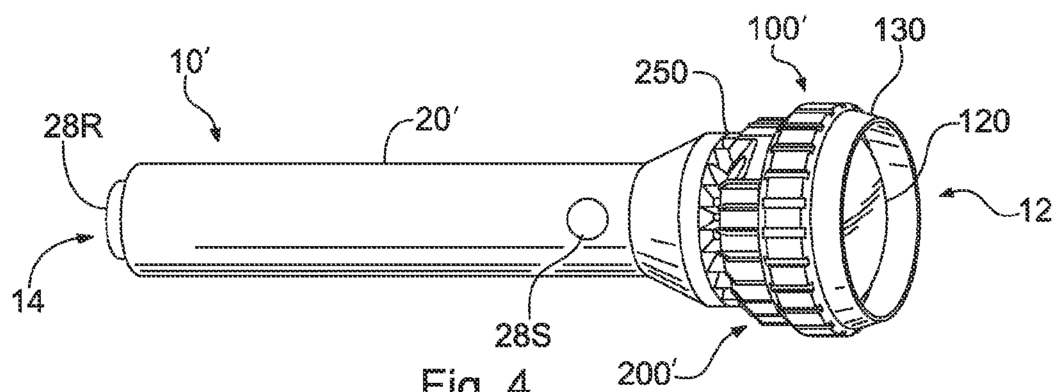
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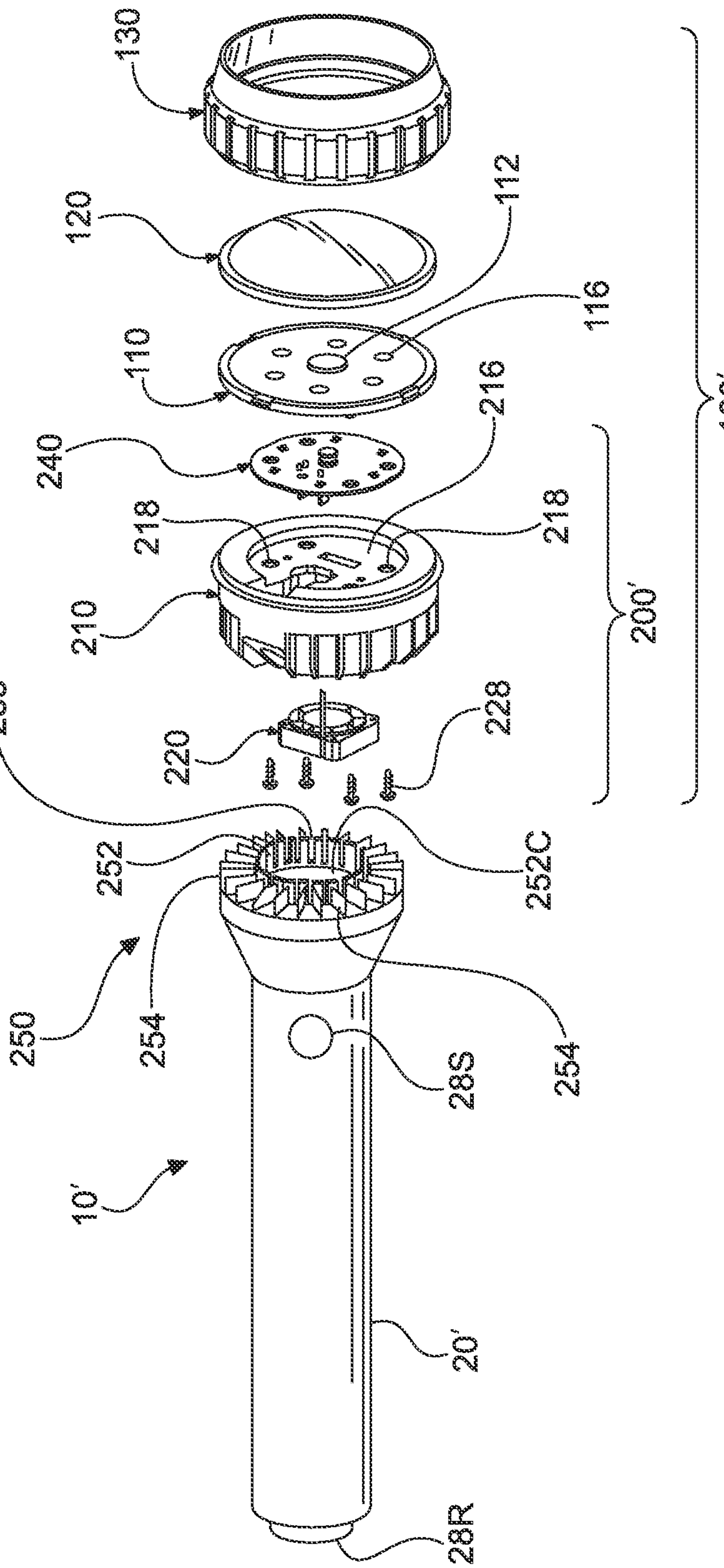
Fig. 4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28S
10′
20′
28R

Fig. 5

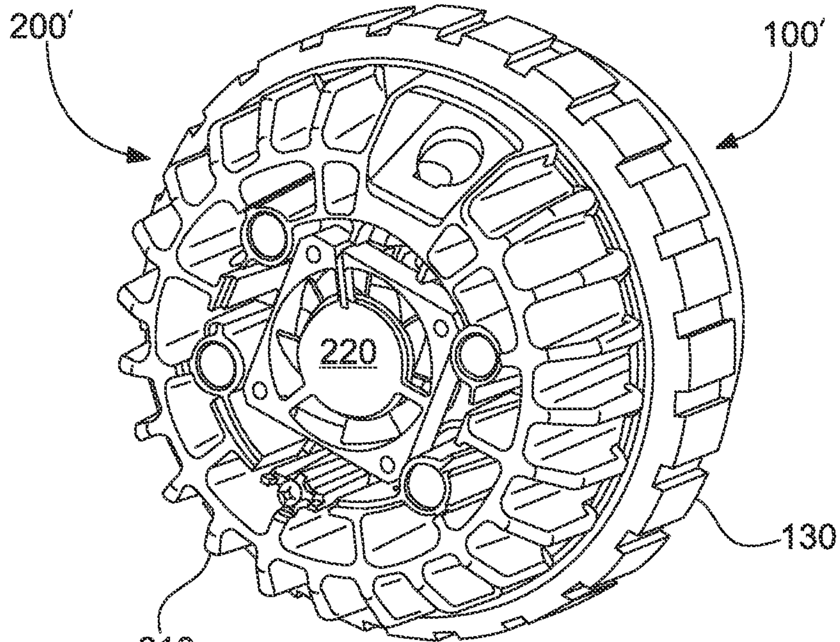

Fig. 5A

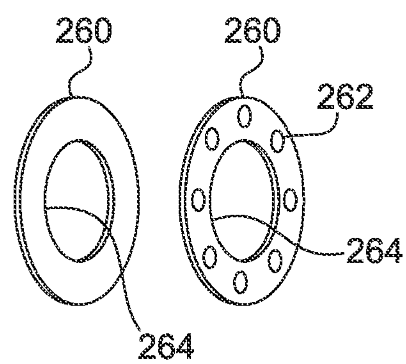

Fig. 5B

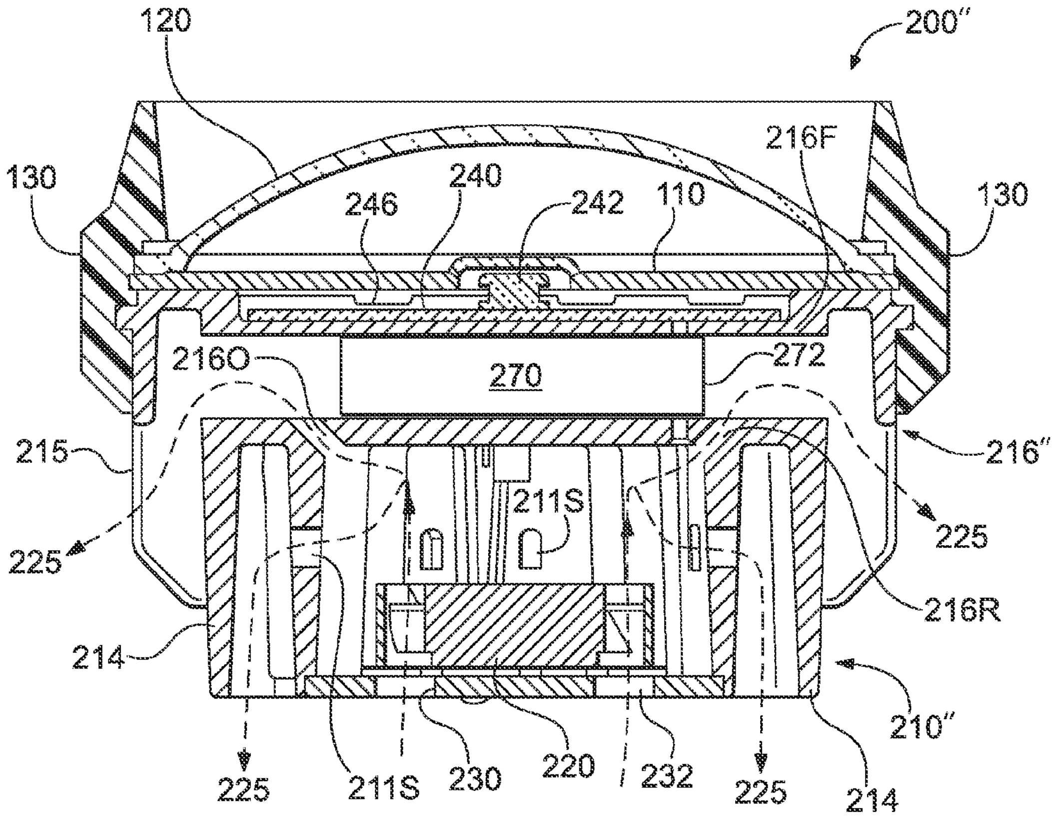

Fig. 6A

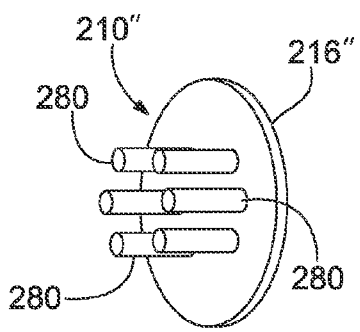

Fig. 6B

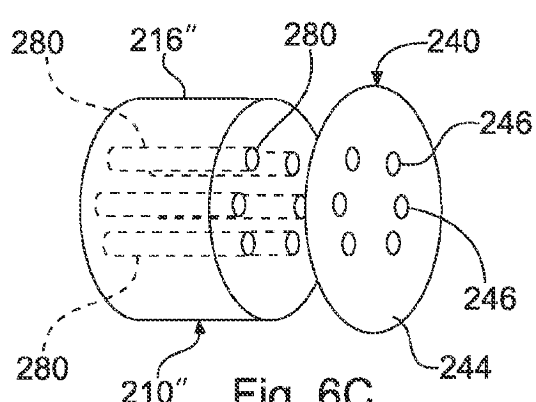

Fig. 6C

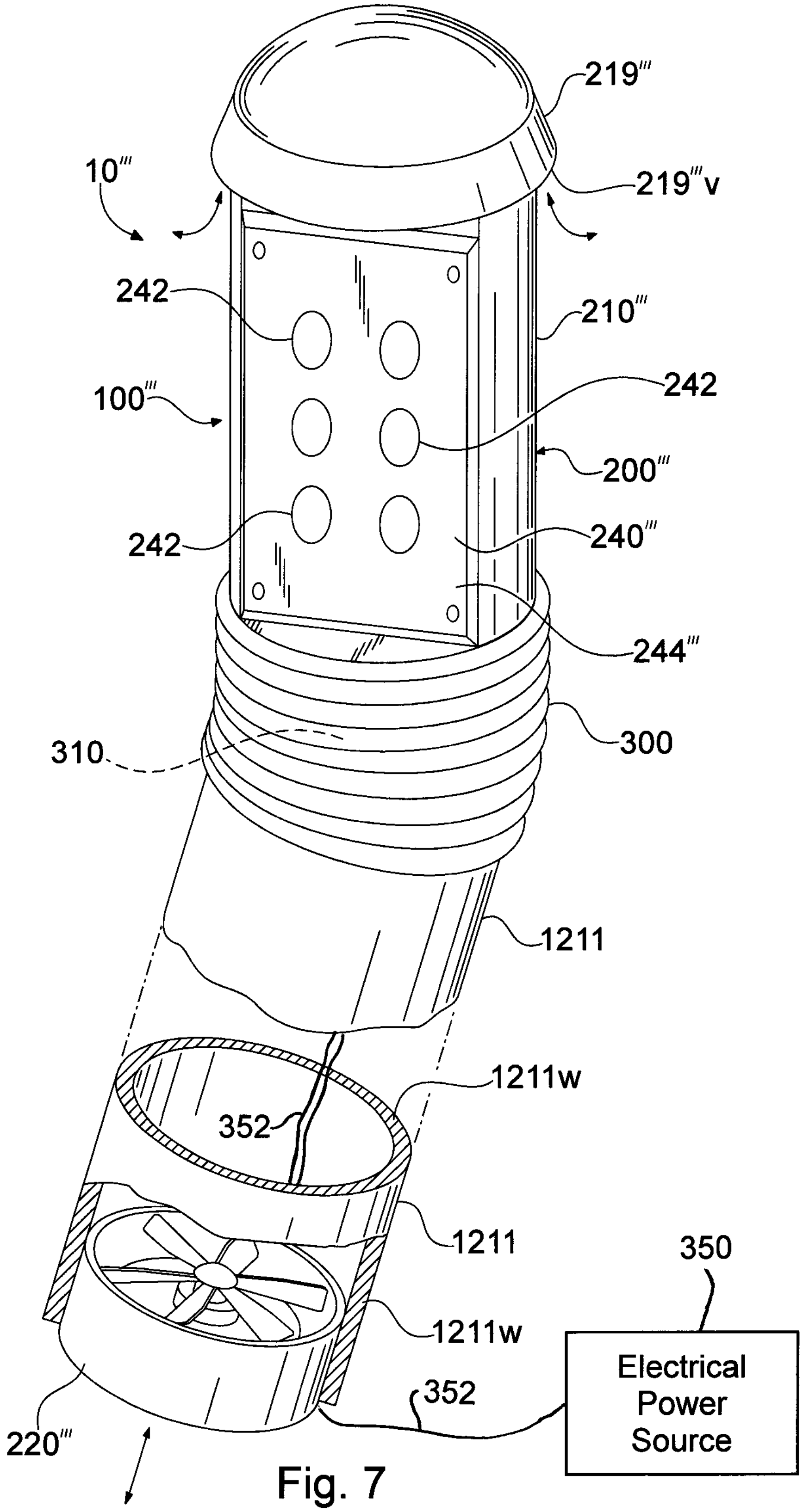

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Fig. 7

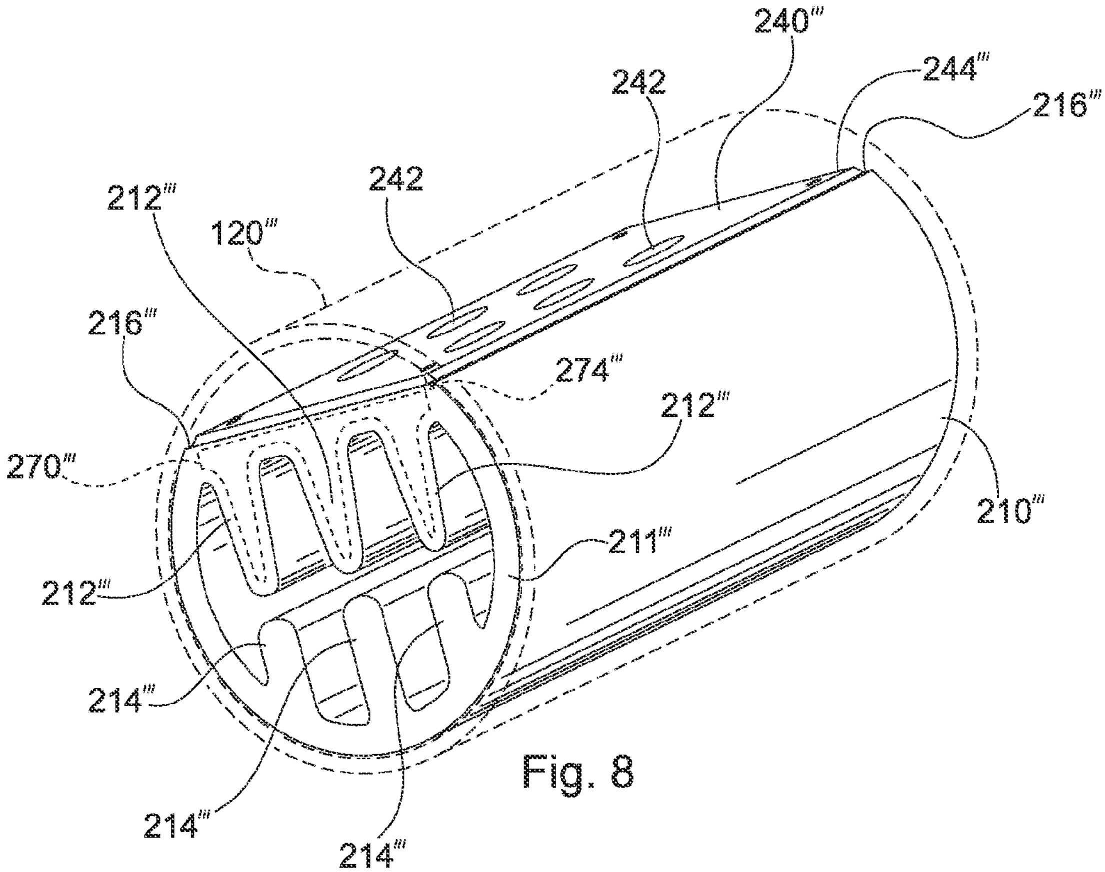
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Fig. 8

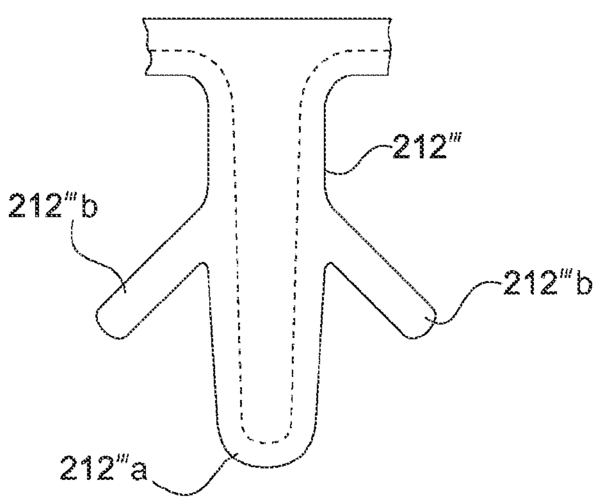
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Fig. 8A

PORTABLE LIGHT HAVING A HEAT DISSIPATER WITH AN INTEGRAL COOLING DEVICE

This Application claims the benefit of U.S. Provisional Patent Application No. 61/264,058 filed Nov. 24, 2009 and entitled "PORTABLE LIGHT HAVING A HEAT DISSIPATER WITH AN INTEGRAL COOLING DEVICE" which is hereby incorporated herein by reference in its entirety.

The present invention relates to a portable heat dissipater and, in particular, to a portable heat dissipater including a cooling device.

The light source for the next generation of professional use flashlights and other portable lights will likely be light-emitting diodes (LED's) almost exclusively. Efficient operation of these LED flashlights requires that the LED, the electronic circuit which controls the operation of the LED, or both, be relatively free from high temperature produced by excess heat. Many of such lights will employ LEDs that produce high light output and consequently also produce significant heat. The presence of excessive heat could result in the failure of the circuit and the failure of the LED light source due to their being heated to an excessive temperature. Therefore, the removal and/or dissipation of the heat that is generated by the LED and/or by the electronic circuit which controls the LED and/or by any other heat generating element is necessary for the efficient and reliable operation of the flashlight.

For certain LED lights it is sufficient to thermally mount the LED to a passive heat sink which conducts heat generated by the LED away from the LED so as to be dissipated primarily by convection, e.g., by exposure of all or part of the heat sink to the atmosphere. To improve convection cooling, the heat dissipater may have fins, posts or other features that increase the surface area that the atmosphere is in contact with.

Presently, LED's and other heat generating elements in flashlights generate heat which accumulates and circulates in an area proximate to the LED or LED subassembly. The presence of a heat sink is only effective to the extent that it is large enough to draw heat away from the LED and to dissipate a sufficient amount of that heat to maintain the LED temperature for efficient operation of the LED. This typically requires direct exposure to an external atmosphere for enhancing the dissipation or transfer of heat from the LED to the atmosphere. Neither or these two solutions is seen to be practical for a professional use flashlight where smallness of size and coolness to touch are features that matter to a user, and where long run times and high light output is required.

Streamlight, Inc. of Eagleville, Pa., has devised a number of effective ways to manage the heat generated by an LED employed as the light source in a flashlight. U.S. Patent Publication No. 2008-0018256 entitled "LED FLASHLIGHT AND HEAT SINK ARRANGEMENT" describes a heat sink arrangement which utilizes thermally conductive elements or members to which the LED and the control circuit are attached to or in thermal contact in order to remove heat from the circuit and the LED, thereby reducing the risk of a performance fault, or, worse, creation of a condition where a fault could result in a dangerous condition depending on where the flashlight is used. The latter is an example of a condition measured by a UL standard regarding flashlights for use in intrinsically dangerous circumstances.

Streamlight, Inc. has been issued U.S. Pat. No. 7,357,534, entitled "FLASHLIGHT PROVIDING THERMAL PROTECTION FOR ELECTRONIC ELEMENTS THEREOF," which relates to a thermally conductive heat sink having a heat dissipating element and a heat collecting element and the use of a thermally conductive material between the electronic circuit and the second surface of the heat sink, thereby thermally coupling the LED and the electronic circuit to the heat sink.

Even those advantageous arrangements may not be adequate for very high power LEDs and/or other heat generating elements employed in a compact configuration. The more heat to be dissipated, the greater the dissipater surface area required to dissipate that heat. As LED light output and the waste heat generated thereby increase, a passively dissipating heat sink can become too large or too heavy or too bulky to be practical. Further, at higher heat dissipation levels, the exposed elements of the heat sink could become sufficiently hot as to potentially become a safety concern.

Accordingly, there is a need for a heat dissipater for a portable light or other apparatus that is more compact than a passive heat sink capable of dissipating the same heat. Desirably, if such heat dissipater were to have an exposed part, the exposed part would preferably operate at a lower temperature than would a passive heat sink of equivalent size.

To this end, a heat dissipater may comprise: a heat sink having a heat generating element thermally coupled thereto, and having a plurality of walls for defining a cavity and plural passages in fluid communication with the cavity; a fluid mover disposed in the cavity of the heat sink for selectively causing a fluid to move through the cavity and the plural passages defined by the walls of the heat sink; and the heat generating element thermally coupled to the heat sink.

The heat dissipater may be employed in a portable light or other portable device or apparatus, with or without a housing.

BRIEF DESCRIPTION OF THE DRAWING

The detailed description of the preferred embodiment(s) will be more easily and better understood when read in conjunction with the FIGURES of the Drawing which include:

FIG. **1** is an isometric view of an example embodiment of a portable light in a lantern configuration that includes a heat dissipater according to the present arrangement;

FIG. **2** is a partial exploded view of the example portable light of FIG. **1**;

FIG. **3** includes FIGS. **3**A and **3**B which are rear isometric views of an example heat dissipater and FIG. **3**C which is a side cross-sectional view thereof;

FIG. **4** is an isometric view of an example embodiment of a portable light in a flashlight configuration that includes a heat dissipater according to the present arrangement;

FIG. **5** is a partial exploded view of the example portable light of FIG. **4**, and FIGS. **5**A and **5**B are isometric views of the rear of the example heat dissipater of FIG. **5** and of a baffle therefor, respectively;

FIG. **6** includes FIG. **6**A which is a cross-sectional view and FIGS. **6**B and **6**C which are isometric views of an alternative embodiment of a heat dissipater according to the present arrangement; and

FIG. **7** is an isometric view of an example embodiment of a portable light in an area light configuration that includes a heat dissipater according to the present arrangement;

FIGS. **8** and **8**A are a partial view of the example portable light of FIG. **7** and of a detail thereof; and

FIG. **9** is a schematic diagram of example electrical and/or electronic circuits suitable for use in the described portable light.

In the Drawing, where an element or feature is shown in more than one drawing figure, the same alphanumeric designation may be used to designate such element or feature in each figure, and where a closely related or modified element is shown in a figure, the same alphanumerical designation primed or designated "a" or "b" or the like may be used to designate the modified element or feature. Similarly, similar elements or features may be designated by like alphanumeric designations in different figures of the Drawing and with similar nomenclature in the specification. It is noted that, according to common practice, the various features of the drawing are not to scale, and the dimensions of the various features are arbitrarily expanded or reduced for clarity, and any value stated in any Figure is given by way of example only.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

In the disclosed heat dissipater, a cooling device typically including a fan is employed to dissipate heat collected by a heat sink that is thermally coupled to a light-emitting diode (LED) subassembly that is located in the head of a portable light, e.g., a flashlight. In the preferred embodiment, the cooling device (fan) is integral to, embedded in and/or a part of, the heat sink to which the LED subassembly is thermally attached. The heat sink and integral fan create a heat dissipater system for the fast, continuous, and efficient dissipation of heat. This thermal control system allows the LED to be maintained more closely to a relatively constant predetermined operating temperature, regardless of variations and/or changes of the intensity of the LED, the current it draws, or the energy it dissipates. The predetermined operating temperature is preferably selected to be close to an "optimum" operating condition for the LED, as that may be defined or desired by an LED manufacturer or a light designer.

The ability to maintain a constant operating temperature for the LED, preferably at or near its "optimum" operating temperature, provides an improvement over the current art. The disclosed heat sink with integral cooling device (e.g., an integral or embedded fan) maintains a sufficiently low temperature so as to conduct a greater flow or volume of heat as generated by high powered LED's no matter how long the run time or how high the light output may be. The greater the degree of cooling provided by the heat sink, which is accomplished in the disclosed arrangement, the greater the ability of the heat sink to collect and dissipate heat which typically results in an environment or operating condition suitable for the efficient use of high powered, long running LED's.

The use of electric fans to cool electronic devices such as computers and appliances is not new. These fans increase air flow so as to increase cooling. Generally, these fans are attached to or are external to a heat sink and they are often large in size—a condition which make such fans impractical for use in a flashlight or other portable light. In addition, electric fans can consume substantial power which is undesirable in a flashlight or portable device because it would greatly compromise the time that a given battery could power the light, and increasing the size (and thus the weight) of the battery is undesirable and in some cases impractical. The present arrangement addresses these problems by making the cooling device fan integral to, embedded in and/or a part of the heat sink, and/or by controlling its operation.

Several electrical blower and electrical fan configurations are commercially available. "Axial fans" move air parallel to the axis of rotation of the fan and provide relatively high flow rates and low pressures. By contrast, "centrifugal fans" or "radial blowers" move air perpendicular to the blower rotational axis and provide relatively low flow rates and high pressures. Other available configurations include tube axial fans, vane axial fans, crossover (tangential) blowers, and multistage blowers.

The configuration of the cooling device and the head sink in the present arrangement will be determined, at least in part, by the size and shape of the flashlight, lantern, or other portable light, with which it will be utilized. The fact that the cooling device is a part of or is integral to the heat sink can improve cooling efficiency and can save considerable space, thereby allowing the disclosed heat dissipater with integral cooling device to be useful for small flashlights while typically allowing the LED run time and/or light output to increase.

FIG. **1** is an isometric view of an example embodiment of a portable light **10** in a lantern **10** configuration that includes a head assembly **100** having a heat sink **200** according to the present arrangement. Example lantern **10** includes a generally rectangular housing **20** having a forward or head end **12** from which light is projected and a rearward end **14**. Housing **20** typically may include handle supports **24**, **26** that extend in like direction for supporting a handle **22** therebetween by which light **10** may be held. Through bolts or pins or rivets (not shown) are typically employed to attach handle **22** to supports **24**, **26**, and such bolts or pins may support respective rings to which a shoulder strap or other strap or lanyard (not shown) may be attached.

Light **10** and housing **20** thereof are generally similar to the LITEBOX® lights which are commercially available from Streamlight, Inc., of Eagleville, Pa., except that the heads of those lights employ a shaped plastic rear piece and not a heat dissipater as described herein. While similar, the FIREBOX® light and the VULCAN® light, which are also available from Streamlight, Inc., do not employ a heat dissipater as described herein.

Light producing head **100** is connected to housing **20** near the head end of lantern **10**. Head assembly **100** is attached to housing **20** by a pivotable connection **40** that includes a swivel connector **42** and a flexible electrical cable **44** that carries electrical conductors for making operative electrical connections between the light source of head **100** and a battery disposed in housing **20**. Swivel connector **42** is preferable attached to heat sink **210** of head **100** by a hollow metal eyelet (not shown) that is passed through hole **46** in heat sink **210** (the head of the metal eyelet bears against heat sink **210**) and through a hole in the cylindrical portion **43** of connector **42** into the space between ears **45** thereof, where it extends through a metal washer on which it is peened or rolled over to permanently attach connector **42** to head **100**.

A through bolt (not shown) passing through holes in ears **45** of connector **42** and through holes of forward handle support **26** is typically employed to attach swivel connector **42** to forward handle support **26** and typically employs a wing nut or other hand tightenable and loosenable nut to facilitate adjustment of the angle of head **100** relative to housing **20** by a user of light **10**.

Head assembly **100** includes a heat dissipater **200** that is described herein below, a lens **120** for protecting the light source of head **100** and/or for shaping the light beam produced thereby, and a retaining ring **130** that attaches to heat dissipater **200** for retaining lens **120** and other elements of head **100**.

Lantern **10** is typically controlled, e.g., turned on and off, and into other operating modes such as flashing or dimming or the like as may be provided, by an electrical switch which is typically mounted on or near forward support **26** in a location convenient for a user. In the arrangement shown, such switch is on the far side of support **26** which is not visible, where it is in a location for convenient activation by a right handed user. Additionally, or alternatively, a control switch may be provided near location **28** on support **26**. Light **10** may also include external terminals for making electrical connection to a battery charger where a rechargeable battery is employed. Typically such terminals are located on housing **20** for making electrical contact to a source of charging, e.g., when light **10** is placed into a charger station or dock.

Housing **20** may also include one or more electronic circuit boards for carrying electronic circuits for controlling the charging and/or discharging of the battery, and/or for controlling operation of the light source contained in head **100**. In lights **10** intended for use in fire and rescue environments, one or more blue lights may be provided at the rear of housing **20**, and the operation thereof, e.g., in a steady on mode or in a flashing mode, may be controlled by circuitry located on circuit board **32**.

FIG. **2** is a partial exploded view of the example portable light **10** of FIG. **1**. Battery **30** is seen to be insertable into housing **20** at the bottom thereof and is typically retained in housing **20** by a cover that is attached to the bottom thereof. The cover may be gasketed to provide a seal against the entry of dirt, debris, moisture or other unwanted materials into housing **20**, and may have feet for light **10** to rest upon when placed on a horizontal surface. Where battery **30** is a rechargeable battery **30**, housing **20** may also house an electrical or electronic circuit **32** for connecting and/or interfacing a rechargeable battery **30** to a battery charger external to housing **20** and light **10**.

Head assembly **100** includes a heat dissipater **200** to which are attached other elements of head **100** that relate to either the light producing function thereof or to the heat dissipating function. Heat dissipater **200** includes a generally circular thermally-conductive heat sink **210** that has a generally flat forward-facing face or surface **216** to or against which light source **240** and various elements **110**, **120**, **130** relating to light source **240** may be attached for conducting heat to thermally conductive heat sink **210**. Specifically, light source **240** includes an LED **242** that is mounted to an electronic circuit board **244** that is disposed adjacent to the relatively flat face **216** of heat sink **210** for the conduction of heat thereto. Heat conduction may be by direct physical contact between circuit board **244** and heat sink **210**, and may be enhanced by the use of thermally conductive material, e.g., a thermally conductive paste or grease, a thermally conductive adhesive, or a thermally conductive membrane, therebetween. Circuit board **244** of light source **240** may typically have holes **248** that align with holes **218** of heat sink **210** for receiving respective screws, pins or other fasteners for retaining light source **240** pressed against flat surface **216** of heat sink **210** in a desired location, thereby to provide thermal coupling therebetween.

Preferably the relatively flat forward-facing surface **216** of heat sink **210** is recessed to define an annular wall having a shape that is substantially the shape of the periphery of circuit board **244** of light source **240**, so that circuit board **244** is registered to a proper position relative to heat sink **210** thereby. Typically, that registration results in LED **242** being substantially on a central axis of heat sink **210** and the central axes of reflector **110**, lens **120** and retaining ring **130**. Reflector **110** typically has substrate **114** having a circular shape similar to that of lens **120** and ring **130**.

Light source may comprise a high power LED **242**, which typically is centrally located on circuit board **244**, and may include additionally or alternatively a plurality of LEDs **246** arrayed on circuit board **244**. LEDs of array **246** are typically evenly spaced in a circular pattern surrounding LED **242**, and typically are lower power LEDs than is LED **242**. Light **10** may be controlled for operation such that only LED **242** is on, or some or all of LEDs **246** are on, or that both LED **242** and LEDs **246** are on at the same time. In addition, control circuitry for LEDs **242**, **246** may provide for selecting different levels brightness for some or all of LEDs **242**, **246**, e.g., dimming and un-dimming of some or all of LEDs **242**, **246**, and/or blinking and flashing modes of operation of some or all of LED **242** and/or LEDs **246**.

Reflector **110** preferably has a plastic LED cover **112** centrally located in substrate **114** for covering LED **242** of light source **240**, and cover **112** may simply be a cover, e.g., for protection, or may have a contoured shape and/or thickness so as to serve as a lens for shaping the light produced by LED **242**. Reflector **110** preferably has plural small reflectors **116**, typically small parabolic reflectors **116**, that align with corresponding small LEDs **246** on circuit board **244** for shaping the beam of light produced by such small LEDs **246**. Small reflectors **116** may be sized and shaped, e.g., made relatively deep or relatively shallow, or relatively wider or relatively narrower, so as to shape the beams of light produced by LEDs **246** in a desired manner, e.g., for providing a spot or a flood of light, or something in between.

Where reflector **110** is a molded plastic, LED cover **112** and small reflectors **116** may be molded into substrate **114**. Where reflector **110** includes a metal substrate **114**, LED cover **112** and small reflectors **116** may be plastic inserts that are fitted into holes in metal substrate **114** or small reflectors **116** may be formed by pressing or stamping the metal of substrate **114**. A metal substrate may improve heat removal from LED **242** and LEDs **246** somewhat, e.g., by providing a path for heat transfer transversely in a direction across the face **216** of heat sink **210** and/or by providing an additional path for heat transfer from the LEDs **242**, **246** to the rim of base **216** of heat sink **210**.

Circular lens **120** is disposed against reflector **110** and is retained thereat by retaining ring **130** that attaches at the outer cylindrical periphery of heat sink **210**, e.g., by ring **130** and heat sink **210** each having threads so as to be threadable together or by ring **130** being elastic and having a projection (e.g., a flange or ridge) or a recess (e.g., a groove or indentation) that corresponds with a recess or projection of heat dissipater **200** so as to snap together or otherwise engage. An O-ring or other gasket or seal may be provided between retaining ring **130** and heat sink **210** and/or between lens **120** and ring **130** to resist the entry of dirt, debris, moisture and other unwanted materials into head **100**.

Heat sink **210** preferably also has a network of fluid passages defined by various walls and fins thereof for the efficient dissipation (removal) of heat produced by light source **240**. An example wall and fin structure of heat sink **210** is better viewed and is described in relation to FIG. **3**. A fluid mover **220**, typically an air moving fan **220**, is disposed in or embedded into the rear of heat sink **210** and is retained therein by four screws or other fasteners **228**, and typically has electrical wires **229** extending from frame **222** for making electrical connection to electrical circuit board **240** for receiving electrical power to operate air mover **220**.

Swivel connector **42** attaches to a hole **46** of heat dissipater **200**, e.g., by a hollow metal eyelet, and flexible cable **44** wraps around swivel connector **42** between ears **45** and passes through the metal eyelet between heat dissipater **210** and housing **20**. Typically cable **44** has electrical wires at the end **44**F that connects to head **200**, e.g., for connecting to circuit board **244** of light source **240**, and has an enlarged elastic stress reliever at the end **44**R that attaches to housing **20**, e.g., to relieve mechanical stress at a hole **27**H within a relatively large slot **27** near the forward end of housing **20** as cable **44** flexes. Thus, electrical cable **44** may flex and move in slot **27** and connector **42** to allow head **100** to swivel with respect to housing **20** so that a user may direct the light produced by head **20** in a desired direction.

FIG. **3** includes FIGS. **3**A and **3**B which are rear isometric views of an example heat dissipater **200** and FIG. **3**C which is a side cross-sectional view thereof. Heat dissipater **200** includes a heat sink **210** that has a plurality of passages for the flow of a fluid therethrough, e.g., air. In general, heat sink **210** may be described as having a circular base **216** from one side of which extend plural coaxial generally circular walls **211**, **213**, **215** to define respective coaxial cylinders. Each of circular walls **211**, **213**, **215** provides additional surface area for enhancing the transfer of heat from heat sink **210** to the surrounding fluid (air) as well as defining passages through which such fluid may flow for further enhancing the dissipation of heat by heat dissipater **200**. The opposite side of circular base **216** provides a generally flat surface or face **216** for receiving electronic circuit board **244** of light source **240** adjacent thereto and thermally coupled thereto, typically, with a thermal grease or thermally conductive adhesive or other thermally conductive compound so as to enhance the thermal coupling between light source **240** and heat sink **210**.

Inner circular wall **211** defines a generally cylindrical cavity **211**C with base **216** closing the bottom end thereof. The end of the cavity **211**C defined by circular wall **211** distal from base **216** is arranged for receiving an air moving device **220** therein. For example, an axial fan **220** may be disposed (embedded) therein with its frame **222** supported by shoulders or ledges of wall **211** and its electrical wires **229** may connect through base **216** to electronic circuit board **244** for receiving electrical power for operating fan **220**. Such shoulders or ledges preferably may have axial holes therein for receiving screws or other fasteners **228** that secure embedded fan **220** to heat sink **210**, e.g., by passing through holes in frame **222** thereof, so that the stator **226** or motor **226** of fan **220** is at the outer end of cavity **211**C so that rotor **224** of fan **220** rotates for moving air into or out of cavity **211**C.

A cover **230** placed over embedded fan **220** and secured to wall **211** by a screw or other fastener **234** substantially closes the cavity **211**C defined by wall **211** and base **216**. Cover **230** has a plurality of openings **232** therethrough, preferably radial slots **232** that are arranged to align with the annular space through which blades of rotatable rotor **224** of fan **220** may move air axially into or out of the cavity **211**C. Wall **211** has a plurality of openings or slots **211S** therethrough which provide plural passages through which air may move radially into or out of cavity **211**C.

Heat sink **210** has an outer generally circular wall **215** that substantially coincides with the circular periphery of circular base **216** and has an intermediate generally circular wall **213** that is between inner circular wall **211** and outer circular wall **215**. Preferably, heat sink **210** further includes a plurality of radial wall segments **212** between inner circular wall **211** and intermediate circular wall **213**, and a plurality of radial wall segments **212** between intermediate circular wall **213** and outer circular wall **215**.

Each adjacent pair of radial wall segments **212** defines with the adjacent portions of circular walls **211**, **213** a fluid (air) cavity or passage **212**C and a majority of these cavities **212**C are connected with cavity **211**C by slots **211S** in circular wall **211**. In the example heat sink **210** as illustrated, there are twelve such cavities **212**C (ten relatively larger and two relatively smaller cavities) and eight of the cavities **212**C are connected by a slot **211S** with cavity **211**C. Preferably, circular walls **211**, **213** extend about the same height from base **216**.

Each adjacent pair of radial wall segments **214** defines with the adjacent portions of circular walls **213**, **215** a fluid (air) cavity or passage **214**C and preferably the number of these cavities **214**C is substantially greater than the number of cavities **212**C. In the example heat sink **210** as illustrated, there are twenty-two such cavities **214**C, e.g. approximately two times the number of cavities **212**C. Preferably, circular wall **215** extends a lesser distance, e.g., about half of the height or less, from base **216** than does wall **213**, thereby to facilitate natural air passage into and out of cavities **214**C for removing heat from walls **213**, **214**, **215**. While ones of cavities **214**C could be connected to ones of cavities **212**C, e.g., by openings in circular wall **213**, they need not be so connected.

In the example heat dissipater **200** illustrated, the flow of air moved in heat sink **210** by air mover **220** is preferably through slots **232** into cavity **211**C, through slots **211S** into cavities **212**C and then rearwardly to be expelled from cavities **212**C. Such flow is shown, e.g., by dashed line **225**. The air so moved initially makes contact with base **216** to which heat produced by LED **242** is conducted, and then makes contact with walls **211**, **212** and **213** to which heat may flow from base **216**. Reasons for preferring that air mover **220** move air in the direction described include that the incoming relatively cooler air initially contacts base **216** which is believed to enhance heat transfer from heat sink **210** and that embedded fan **220** is itself cooled by such relatively cooler air which is believed to tend to extend the useful life of fan **220**.

As shown in FIG. **3**C, electronic circuit board **244** of light source **240** supports LED **242** generally in a central region thereof, and is adjacent to base **216** of heat sink **210**, preferably in good thermal contact therewith. Reflector **110** includes a circular portion **114** that is adjacent light source **240** and a dome portion **112** that surrounds and protects LED **242**, and which may be utilized as a lens for shaping the light produced by LED **242**. Light source **240** and reflector **110** are secured to heat dissipater **200** by fasteners that extend through respective holes in circuit board **244** and reflector **110** into base **216** of heat sink **210**. Preferably such fasteners are of a heat conducting material so as to enhance heat transfer from light source **240** to heat sink **210**.

In a preferred embodiment, heat sink **210** has a recess **217** in face **216** thereof that has a shape and size that corresponds to the shape and size of the periphery of circuit board **244**. As a result, when circuit board **244** is placed in recess **217** of heat sink **210** it is disposed in a predetermined position relative to heat sink **210**, e.g., so that centrally located LED **242** is located in the position in which it will properly align with reflector **110** and lens **120** of light head assembly **100**. Further, the periphery of circuit board **244** and the periphery of recess **217** are preferably not circularly symmetric, so that the rotational position of circuit board **244** relative to heat sink **210** is also predetermined and connection points of circuit board **244** will be in the proper locations for receiving electrical conductors, e.g., electrical leads **229** of air mover fan **220** and lead wires **44**F of wire cable **44**, which pass through one or more openings in heat sink **210**.

LED **242** may be mounted to circuit board **244** in any of several ways. For example, LED **242** could be mounted through a hole in circuit board **244** so that the base of LED **242**, from which heat generated by LED **242** may be conducted, can be directly against the surface **216** of heat sink **210**. Alternatively, LED **242** may be mounted to the surface of circuit board **244** as illustrated and circuit board **244** may include thermally conductive features adjacent to LED **242** and proximate to LED **242** for transferring heat from LED **242** to base **216** of heat sink **210**. Such thermally conductive features may include, e.g., conductive areas on one or both sides of circuit board **244**, conductive vias through circuit board **244**, solder-filled holes through circuit board **244**, thermally conductive metal fasteners for securing circuit board **244** to heat sink **210**, and the like.

In particular, an array of plated-through holes may be provided in circuit board **244** at a location over which a heat generating component will be mounted, which holes fill with solder when circuit board is soldered, so as to provide an array of thermally conductive vias for conducting heat away from such component. In general, features that increase thermal mass, thermal conductivity and/or the thermally conductive area of contact will generally improve heat transfer.

FIG. **4** is an isometric view of an example embodiment of a portable light **10'** in a flashlight **10'** configuration that includes a heat dissipater **200'** according to the present arrangement. Flashlight **10'** includes a housing **20'** at a forward end **12** of which is located a head assembly **100'** that selectively produces light. Typically housing **20'** includes one or more switches **28** for selectively controlling the production of light, and has an internal cavity for receiving a source of electrical power, e.g., a battery. Switches **28** may include, e.g., a switch **28**S located on the side of housing **20'**, typically closer to the forward end **12** thereof, and possibly on the head **100'** thereof, and/or a switch **28**R located at the rearward or tail end **14** thereof. Such switches **28**S, **28**R may operate independently or in coordination for controlling all or some of the operation of light **10'**.

Head **100'** at the forward end **12** of light **10'** includes a light source and may include electrical and/or electronic circuits for operating and/or controlling the light source. Head assembly **100'** includes a heat dissipater **200'** along with a reflector **110** and lens **120** that are retained with heat dissipater **200'** by a retaining ring **130**, all as described above.

FIG. **5** is a partial exploded view of the example portable light **10'** of FIG. **4**, and FIGS. **5**A and **5**B are isometric views of the rear of an example flashlight head **100'** having a heat dissipater **200** of FIG. **5** and of a baffle **260** therefor, respectively. Flashlight head **100'** and heat dissipater **200'** may be identical to light head **100** and heat dissipater **200**, respectively, except that cover **230** is preferably omitted and swivel connector **42** may optionally be omitted, if desired, as is illustrated. Thus the description of head **100** and heat dissipater **200**, and their function, above also describes flashlight head **100'** and heat dissipater **200'** and their function.

In the case of portable light **10** above, which is a lantern **10**, the rear of heat dissipater **200** is exposed, and so air may circulate around and within heat dissipater **200** relatively unaffected by the housing **20** of lantern **10**. Such is not the case, however, for portable light **10'** which is in the configuration of a flashlight because flashlight housing **20'** thereof would tend to block the rear of heat dissipater **200'** and thus would interfere with the circulation of air in and around heat dissipater **200'**.

To allow head assembly **100'** to attach to housing **20'** while having suitable circulation of air in and around heat dissipater **200'**, housing **10** preferably includes provisions for integrating with heat dissipater **200'** in a way that allows the desired thermodynamic condition. A suitable mechanical and thermal interface **250** between housing **20'** and heat dissipater **200'** includes walls and air passages that cooperate with the walls and air passages of heat sink **100'** to allow the flow of air inward to embedded fan **220** which is integrated into and/or embedded in heat sink **210**.

Head assembly **100'** may be attached to flashlight housing **20'** by all or some of the screws or other fasteners that extend into or through holes **218** in heat sink **210** extending further than heat sink **210** to engage corresponding holes of interface **250** of flashlight housing **20'** or by two or more screws or other fasteners inserted through housing **20'** to engage heat dissipater **200'**, e.g., two or more of the holes **218** of heat sink **210**. Alternatively, interface **250** may be threadable or otherwise attachable onto and off of housing **20'** and so may be attached to heat dissipater **200'** by screws or other fasteners that pass through holes in interface **250** and into holes **218** of heat sink **210**, or interface **250** may be threadable to housing **20'** and to heat dissipater **200'**.

Air passage defining elements **250** serve to channel air being drawn to embedded fan **220** which is completely surrounded by heat sink **210** and elements **250** without a cover **230** being needed. Interface **250** includes a generally circular wall **252** extending forwardly toward head end **12** of light **10'** and being of similar diameter to that of circular wall **213** of heat sink **210** with which it is generally coaxial. Circular wall **252** has a plurality of openings or slots **253** therein through which air may flow to reach the cavity **252**C within circular wall **252** from which it may be drawn through air mover **220** into and through heat sink **210**.

Interface **250** further includes radial walls **254** that extend radially outward from circular wall **252** to further define air flow passages. While air flowing from heat sink **210** may generally escape radially outwardly between walls **254**, walls **254** provide additional surface area that can also serve to dissipate heat. When appropriate given the amount of heat to be dissipated by dissipater **200'** and interface **250**, an annular baffle **260** or other shaped baffle **260** may be provided between dissipater **200'** and interface **250**, or as part of either one or both of them, so as to direct the flow of air through heat dissipater **200'** and interface **250** in a suitable manner, e.g., to separate the relatively cooler air flowing in from the relatively warmer air flowing out.

The particular arrangement of such baffle **260** would be defined in consideration of the respective locations of slots **211**S of heat sink **210** and of slots **253** of interface **250** for defining desired respective passages through which the cooling fluid, e.g., air, may flow into and out of heat dissipater **200'**. Typically, a flat annular baffle **260** could have a central opening **264** having a diameter similar to or slightly smaller than the diameter of cylindrical wall **252**, which diameter would typically be similar to the diameter of cylindrical wall **211** of heat sink **210**, and could have an outer diameter that is similar to or slightly larger than the outer diameter of interface **250** and/or cylindrical wall **213** of heat sink **210** which would have slots therein for allowing the cooling fluid to pass radially outwardly through wall **213**. Where adjacent pairs of radial fins **254** define passages through which air may flow into cavity **252**C and other adjacent pairs of radial fins **254** define passages through which air may flow from outwardly from cavities of heat sink **210**, baffle **260** may have openings **262** therethrough for allowing air flowing out of the cavities of heat sink **210** into the passages between adjacent radial fins **254** of interface **250**, in addition to central opening **264**.

FIG. **6** includes FIG. **6**A which is a cross-sectional view and FIGS. **6**B and **6**C which are isometric views of an alternative embodiment of a heat dissipater **200"** according to the present arrangement, which may be similar to heat dissipater **200**, **200'** as described above. Heat dissipater **200"** includes at least one heat pipe **270**, **280** for conducting heat from a warmer location near which heat is generated to a cooler location where heat may be dissipated. A heat pipe is known to have a closed cavity in which is a working fluid that evaporates to a vapor at a relatively warmer location and condenses to a liquid at a relatively cooler location, thereby to transfer heat from the relatively warmer location to the relatively cooler location. A wick may be provided within the closed cavity of a heat pipe to assist the return of the liquid condensed working fluid from the relatively cooler location to the relatively warmer location by capillary action. Suitable working fluids may include, e.g., ammonia, water, methanol, ethanol, and acetone.

In FIG. **6**A, heat pipe **270** is disposed between the first side **216**F of base **216**" of heat sink **210**" and the second side **216**R thereof for transferring heat from LED **242** and/or LEDs **246** to walls **211-215** from which it may be removed by cooling fluid, e.g., air, passing thereby. Heat pipe **270** has a cavity **272** therein in which a working fluid is disposed. Heat pipe **270** may include a casing that defines an interior cavity thereof containing the working fluid thereof, or the cavity containing working fluid may be provided within the circular base **216**" of heat sink **210**" without a separate casing. Heat sink **210**" may include plural additional passages **216**O through base **216**" through which cooling fluid moved by fan **220** may be caused to flow, e.g., in an axially forward and/or radially outward direction. By way of example, slots **211**S of heat sink **210**" are shown relatively smaller than those of heat sink **210** and air flow caused by fan **220** passes through both openings **211**S and **216**O, as indicated by dashed arrows **225**.

In FIGS. **6**A and **6**B are shown a set of relatively long, relatively small diameter heat pipes **280** that are disposed at least in part in base **216**" of heat sink **210**" in an array generally corresponding to an array including plural LEDS, e.g., LEDs **246** of light source **240** circuit board **244** adjacent heat sink **210**" (shown simplified). In this arrangement, light source **240** may or may not include a central relatively larger LED **242**. Each heat pipe **280** has a cavity therein in which a working fluid is disposed. Each heat pipe **280** may include a casing that defines the cavity containing the working fluid thereof, as shown in FIGS. **6**B and **6**C, or the cavity containing working fluid may be provided within the circular base **216**" of heat sink **210**" without a separate casing, e.g., by drilled or bored blind holes that are covered after a working fluid is placed therein, as shown in FIG. **6**C. Where heat pipes **280** having a separate casing are employed, they may be of sufficient length to extend through the circular base **216**" as illustrated in FIG. **6**B into the fluid passages defined by the various walls **211-215** of heat sink **210**" for being in direct thermal contact with the cooling fluid passing and/or moving through heat sink **210**".

Heat sink **210**" while shown in a simplified form, preferably includes various walls defining various fluid passages through which air mover **220** may cause fluid, e.g., air, to flow for efficiently dissipating heat from a heat source thermally coupled to heat sink **210**" to the surrounding environment. The arrangement of heat sink **210**" allows it to be included in a head for a portable light, e.g., a light in a lantern configuration or in a flashlight configuration or in an area light configuration or in anther desired configuration.

FIG. **7** is an isometric view of an example embodiment of a portable light **10**"' in an area light configuration that includes a heat dissipater **200**"' according to the present arrangement, and FIGS. **8** and **8**A are partial views of the example portable light **10**"' of FIG. **7** showing details thereof. Portable area light **10**"' includes a head assembly **100**"' comprising a heat dissipater **200**"' including a heat sink **210**"' to which is mounted a light source **240**"'. Heat sink **210**" of head assembly **200**"' typically includes circular wall **211**"' and interior walls **212**"', **214**"' that define fluid passages through which a fluid, most typically air, can flow. Walls **212**"', **214**"' may be of any desired shape and so may have parallel sides as illustrated for walls **214**"' or may be tapered as illustrated for walls **212**"'. Double ended arrows at the vents **219**"'V of venting cover **219**"' and at the end of hollow tubular member **1211** indicate that fluid may be made to flow in one direction or the other, e.g., as by a fluid mover **220**"' integrally disposed in tubular member **1211**, typically near an end thereof remote from dissipater **200**"'.

Light **10**"' preferably includes a hollow tubular member **1211** to which head assembly **100**"' is physically connected by a movable joint **310** (not visible). Preferably, the movable joint may be an articulated joint **310** permitting movement of head **100**"' with at least two degrees of freedom relative to member **1211**. The articulated joint may include one or more pivotable connections pivotable in one or more different planes or may include a ball and socket connection providing degrees of freedom of relative movement in plural planes. Tubular member **1211** has a generally circular wall **1211***w* that defines a fluid passage through member **1211** and essentially extends from heat sink **210**"' to fluid mover **220**"'. A flexible sheath **300** is preferably provided between tubular member **1211** and head **100**"' for defining a fluid passage therebetween, e.g., providing fluid communication between respective fluid passages in tubular member **1211** and in head **100**"'.

In an example embodiment wherein head assembly **100**"' is generally cylindrical, heat dissipater **200**"' is generally cylindrical and has a relatively flat base surface **216**"' upon which is disposed light source **240**"'. Light source **240**"' may comprise an electronic circuit board **244**"' upon which are mounted a plurality of light emitting diodes (LEDs) **242**, typically higher power LEDs. A lens **120**"' may be provided to cover light source **240**"' and generally prevent dirt and other debris from being deposited thereon. Lens **120**"' may simply be a transparent or translucent cover of rectangular or arcuate shape that covers light source **120**"' or lens **120**"' may be a cylindrical lens that surrounds light source **120**"' and heat sink **210**"' as shown. A reflector may be provided for LEDs **242**, e.g., in similar manner to that described regarding reflector **110** hereinabove, but is not necessary, particularly where a flood of light over an area is desired.

Circuit board **244**"' is generally planar and is mounted in thermal communication with base surface **216**"' of heat sink **210**"' for conducting heat generated by LEDs **242** to heat sink **210**"'. Circuit board **244**"' typically has features for thermally coupling LEDs to heat sink **210**"' such as thermally conductive vias, a metal or other thermally conductive core, or openings for allowing LEDs **242** to be directly thermally coupled to base surface **216**"' of heat sink **210**"', and may be attached to base surface **216**"' by fasteners, e.g., screws, pins, clips and the like, thermally conductive adhesive or other suitable means.

Heat sink **210**"' has a generally circular wall **211**"' defining a fluid passage and has walls **212**"' and **214**"' extending therefrom for further defining a fluid passage for the fluid, typically air, moved by fluid mover **220**"', typically an electrical fan. Walls **211**"', **212**"', **214**"' increase the area that fluid moving through heat sink **210**"' contacts thereby to improve heat transfer and lower thermal resistance. Walls **212**"', **214**"' typically have a tapered cross-sectional shape to improve heat conduction therethrough.

Wall configurations other than that illustrated may be employed to achieve a desired degree of heat transfer in view of the flow of fluid provided by fluid mover **220**"'. For example, walls **212**"' and/or **214**"' may have a more complex cross-sectional shape for providing greater surface area. In one example, shown in FIG. **8**A, wall **212**"' has sideways extending arms 212'''*b* on opposite sides thereof and an end 212''' a at the end thereof. Preferably, heat sink 210''' has walls 211''', 212''', 214''' in a configuration that allows heat sink 210''' to be extruded, e.g., extruded aluminum.

Optionally, heat sink 210''' may include a heat pipe 270''' to further enhance heat transfer from LEDs 242. A heat pipe 270''' may be a thin rectangular heat pipe disposed between light source 240''' and the base 216''' of heat sink 210''' or may be a more complex shape to complement the shapes of walls 211''', 212''' as illustrated. The cavity of heat pipe 270''' which contains a working fluid may be formed in part by the extrusion of heat sink 210''', e.g., extending into the central regions of radial walls 212'''. and in part by a cover 274''', e.g. at the open ends thereof. While a thin rectangular heat pipe may be provided as a separate part that is attached to heat sink 210''', a heat pipe 270''' of more complex cross-section preferably is provided by covering a cavity formed in the extruding of heat sink 210'''.

An electrical power source 350, e.g., a battery, generator or connection to an external power source 350, may be located at or near the end of tubular member 1211 remote from head 100''' for powering fan 220''' as well as light source 240''', or may be located closer to or in head 100'''. Electrical power may be conducted to head 100''' via electrical wires 352, e.g., electrical wires 352 passing through the interior of member 1211 and flexible sheath 300.

Venting cover 219''' is preferably at the upper end of head assembly 100''' where light 10''' is intended for outdoor use for providing a cover 219''' to keep rain and other debris from entering head 100'''. Vents 219'''*v* thereof may preferably be provided by one or more openings located circumferentially around the bottom periphery of venting cover 219''' so as to not capture falling rain or debris.

FIG. 9 is a schematic diagram of example electrical and/or electronic circuits 400 suitable for use in the described portable light 10, 10'. Circuit board 244 of light source 240 may typically carry all or part of the electronic circuitry 400 utilized for operating light source 240 and/or air mover (fan) 220. Such circuitry 400 may include current and/or voltage control and regulation for LED 242 and for small LEDs 246, including predetermined varying thereof as a function of temperature, for operating LEDs 242, 246 at desired current levels, brightness levels and/or temperatures. One example desirable operating condition for high power LED 242 would be to regulate the current flowing through LED 242 to be at or near a condition of high efficiency of conversion of electrical energy into light, and also to operate air mover 220 so as to tend to maintain LED 242 at a temperature at which its efficiency is high.

In addition, a control circuitry 400 for air mover 220 may also be provided on circuit board 244 so that air mover 220 may be made to operate or operate faster as temperature increases and to cease to operate or to operate more slowly as temperature decreases. Preferably, fan 220 operates responsive to temperature as sensed relatively close to high power LED 242, but may be sensed at heat sink 210, e.g., near surface 216, or at a location on circuit board 244. Temperature may be sensed by any convenient temperature sensitive element, e.g., by a thermistor, or by a thermostatic or other thermally responsive switch.

Electrical power provided by battery 30 and charging circuit 32 is coupled to control circuitry 400 which controls the selective application of electrical power to light source 240 which includes LED 242 and LEDs 246 for producing light, responsive to operation of switch SW, e.g., by a user. Switch SW may be operative for controlling the LED driver 440 of circuitry 400 for turning light source 2400N and OFF, either momentarily or continuously, and may also be operative to cause light source 240 to operate at different brightness levels, to dim and/or un-dim, and/or to cause light source 240 to flash or blink between ON and OFF conditions. The fan driver 420 of control circuitry 400 is responsive to thermal sensing device T for selectively applying electrical power to fluid mover 220, e.g., an air mover or fan, to cause fan 220 to move a cooling fluid, e.g., air, over heat sink 210 of dissipater 200 for dissipating the heat produced by operation of LED 242 and/or LEDs 246 and/or other heat producing elements, e.g., electrical or electronic components on circuit board 244.

By way of example, and not of limitation: Heat sink 210, 210", 210''' may be made of aluminum or another suitable metal having good thermal conductivity, such as brass, or of a highly-thermally conductive resin, and may be cast, molded, or machined as a single piece, or may be made of a cast, molded or machined base to which a section of an extruded wall structure is attached, e.g., as by brazing or thermally-conductive adhesive. Cover 230 may be made of a metal, e.g., aluminum, or of a plastic. Reflector 110 may be made of a plastic, such as polycarbonate, or of a metal, e.g., aluminum, with one or more plastic inserts, by molding or pressing or stamping, Lens 120 may be made of similar plastic materials, and lens 120 and reflector 110 may be joined together at their peripheries, e.g., by heat or ultrasonic welding or by adhesive. Retaining ring 130 may be made of a suitable elastic material, such as a molded rubber, urethane or other plastic, so as to snap on over the rim of heat dissipater 200, 200', or may be of a suitable metal, e.g., aluminum, and have threads so as to engage threads on the rim of heat dissipater 200, 200'.

Also by way of example, and not limitation: Heat sink 210 may be about 4.65 inches (about 118 mm) in diameter and about 1.86 inch (about 47 mm) thick, and may be fabricated by machining, casting, molding, and/or extrusion, either as a single piece or as individual pieces, e.g., as an extruded wall structure 211-215 and a machined base 216 that are brazed or adhesively attached together. Fan 220 may be, e.g., an about 1.5×1.5 inches (about 38 mm×38 mm) rectangular axial fan operable from DC voltage, such as a GM series DC fan available from Sunon, Inc. (USA) located in Brea, Calif., and in China. LED 242 may be a type C4 high power LED available from the Philips Lumileds Lighting Company located in San Jose, Calif. or from Cree, Inc., located in Durham, N.C. Circuit board 244 may be made of FR4 or fiberglass-impregnated resin or other suitable material.

A portable light heat dissipater 200, 200', 200", 200''' may comprise: a heat sink 210, 210', 210" having a first side for having a light source 240 thermally coupled thereto, and having a plurality of walls 211-215 extending from a second side thereof for defining a cavity and plural passages in fluid communication with the cavity; a fluid mover 220 disposed in the cavity of heat sink 210, 210', 210", 210''' for selectively causing a fluid to move through the cavity and the plural passages defined by the walls 211-215 of heat sink 210, 210', 210", 210'''; and a light source 240 disposed adjacent to and thermally coupled to the first side of heat sink 210, 210', 210", 210'''. Portable light heat dissipater 200, 200', 200", 200''' may further comprise: an electronic circuit 400 proximate heat sink 210, 210', 210", 210''' for controlling electrical power applied to light source 240; or an electronic circuit 400 proximate heat sink 210, 210', 210", 210''' for controlling operation of fluid mover 220; or an electronic circuit 400 proximate heat sink 210, 210', 210", 210''' for controlling electrical power applied to light source 240 and operation of fluid mover 220. Electronic circuit 400 may control electrical power applied to light source 240 or may control operation of fluid mover 220 or may control both responsive to the temperature of light source **240**. Heat sink **210**, **210'**, **210"**, **210'''** may comprise a generally circular base providing the first side for having a light source **240** coupled thereto, and a plurality of generally cylindrical walls **211-215** extending from the base of heat sink **210**, **210'**, **210"**, **210'''**, wherein an inner one of said cylindrical walls **211-215** defines the cavity for receiving fluid mover **220**, and wherein at least one of cylindrical walls **211-215** has openings therethrough for defining the plural passages. The heat sink **210**, **210'**, **210"**, **210'''** may comprise a base **216** providing the first side for having the light source **240**, **240'**, **240"**, **240'''** coupled thereto, an enclosing wall **211'''** extending from base **216** defining a passage and a plurality of generally radial walls **212'''** extending from at least the base **216** of heat sink **210**, **210'**, **210"**, **210'''** into the passage defined by enclosing wall **211'''** to define one or more of the plural passages adjacent base **216**, and a hollow member **1211** extending therefrom defining a cavity in fluid communication with the plural passages, wherein hollow member **1211** defines the cavity for receiving fluid mover **220**. An articulated connection **300** between heat sink **210**, **210'**, **210"**, **210'''** and hollow member **1211** and a flexible sheath **310** may enclose the articulated connection and providing a fluid passage between hollow member **1211** and heat sink **210**, **210'**, **210"**, **210'**. Heat sink **210**, **210'**, **210"**, **210'''** may include at least one heat pipe **270**, **280** coupling the first and second sides thereof. Electronic circuit **400** may be disposed on a circuit board **244** defining a periphery of a given shape and size, and the heat sink **210**, **210'**, **210"**, **210'''** may have a recess **217** in the first side thereof, the recess having a shape and size corresponding to the given shape and size of the periphery of said circuit board **244**, and the circuit board **244** may be disposed in the recess **217**. Heat sink **210**, **210'**, **210"**, **210'''** may comprise a generally circular base providing the first side **216** for having a light source **240** or heat generating element **240** coupled thereto, and a plurality of generally cylindrical walls **211-215** extending from the base of said heat sink **210**, **210'**, **210"**, **210'''**, wherein an inner one **211** of the cylindrical walls **211-215** defines the cavity **211**C for receiving the fluid mover **220**, and wherein at least one **211**, **213** of the cylindrical walls **211-215** has openings **211**S, **213**S therethrough for defining the plural passages. Heat sink **210**, **210'**, **210"**, **210'''** may include at least one heat pipe **270**, **280** coupling the first and second sides thereof. Heat generating element **240** may include: at least one light emitting diode **242**, **246**; or a high power light emitting diode **242**; or an array of light emitting diodes **246**; or a high power light emitting diode **242** and an array of light emitting diodes **246**. Fluid mover **220** may include a fan **220** for moving air. Heat dissipater **200**, **200'**, **200"**, **200'''** may further comprise: a cover **230** adjacent fluid mover **220** and having openings **232** therethrough through which the fluid moved by fluid mover **220** moves; or a thermal interface **250** adjacent fluid mover **220** and defining passages through which the fluid moved by fluid mover **220** moves; or a thermal interface **250** adjacent fluid mover **220** and having a plurality of radial walls **254** defining passages through which the fluid moved by fluid mover **220** moves.

A portable light **10**, **10'** may comprise: a housing **20**, **20'** defining a cavity for receiving a source of electrical power therein; and a head **100**, **100'** connected to housing **20**, **20'** and including a light source **240**, a reflector **120** and a heat dissipater **200**, **200'**, **200"**, **200'''**. Heat dissipater **200**, **200'**, **200"**, **200'''** may comprise: heat sink **210**, **210'**, **210"**, **210'''** having a first side for having a light source **240** thermally coupled thereto, and having a plurality of walls **211-215** extending from a second side thereof for defining a cavity and plural passages in fluid communication with the cavity; and a fluid mover **220** disposed in the cavity of heat sink **210**, **210'**, **210"**, **210'''** for selectively causing a fluid to move through the cavity and the plural passages defined by the walls **211-215** of heat sink **210**, **210'**, **210"**, **210'''**; wherein light source **240** is disposed adjacent to and thermally coupled to the first side of heat sink **210**, **210'**, **210"**, **210'''**. Portable light **10**, **10'** may further comprise: an electronic circuit **400** proximate heat sink **210**, **210'**, **210"**, **210'''** for controlling electrical power applied to light source **240**; or an electronic circuit **400** proximate heat sink **210**, **210'**, **210"**, **210'''** for controlling operation of fluid mover **220**; or an electronic circuit **400** proximate heat sink **210**, **210'**, **210"**, **210'''** for controlling electrical power applied to light source **240** and operation of fluid mover **220**. Electronic circuit **400** may control electrical power applied to light source **240** or may control operation of fluid mover **220** or may control both responsive to the temperature of light source **240**. Heat sink **210**, **210'**, **210"** may comprise a generally circular base providing the first side for having a light source **240** coupled thereto, and a plurality of generally cylindrical walls **211-215** extending from the base of heat sink **210**, **210'**, **210"**, **210'''**, wherein an inner one **211** of cylindrical walls **211-215** defines the cavity for receiving fluid mover **220**, and wherein at least one of cylindrical walls **211-215** has openings therethrough for defining the plural passages. The heat sink **210**, **210'**, **210"**, **210'''** may comprise a base **216** providing the first side for having the light source **240**, **240'**, **240"**, **240'''** coupled thereto, an enclosing wall **211'''** extending from base **216** defining a passage and a plurality of generally radial walls **212'''** extending from at least the base **216** of heat sink **210**, **210'**, **210"**, **210'''** into the passage defined by enclosing wall **211'''** to define one or more of the plural passages adjacent base **216**, and a hollow member **1211** extending therefrom defining a cavity in fluid communication with the plural passages, wherein hollow member **1211** defines the cavity for receiving fluid mover **220**. An articulated connection **300** between heat sink **210**, **210'**, **210"**, **210'''** and hollow member **1211** and a flexible sheath **310** may enclose the articulated connection and providing a fluid passage between hollow member **1211** and heat sink **210**, **210'**, **210"**, **210'**. Heat sink **210**, **210'**, **210"**, **210'''** may include at least one heat pipe **270**, **280** coupling the first and second sides thereof. A pivot connector **42** may connect heat dissipater **200**, **200'**, **200"**, **200'''** to housing **20**, **20'**, wherein head **100**, **100'**, **100"**, **100'''** and housing **20**, **20'** are in a lantern configuration. A thermal interface **250** may connect heat dissipater **200**, **200'**, **200"**, **200'''** to housing **20**, **20'**, wherein head **100**, **100'**, **100"**, **100'''** and housing **20**, **20'** are in a flashlight configuration. Electronic circuit **400** may be disposed on a circuit board **244** defining a periphery of a given shape and size, and the heat sink **210**, **210'**, **210"**, **210'''** may have a recess **217** in the first side thereof, the recess having a shape and size corresponding to the given shape and size of the periphery of said circuit board **244**, and the circuit board **244** may be disposed in the recess **217**. Heat sink **210**, **210'**, **210"**, **210'''** may comprise a generally circular base providing the first side **216** for having a light source **240** or heat generating element **240** coupled thereto, and a plurality of generally cylindrical walls **211-215** extending from the base of said heat sink **210**, **210'**, **210"**, **210'**, wherein an inner one **211** of the cylindrical walls **211-215** defines the cavity **211**C for receiving the fluid mover **220**, and wherein at least one **211**, **213** of the cylindrical walls **211-215** has openings **211**S, **213**S therethrough for defining the plural passages. Heat sink **210**, **210'**, **210"**, **210'''** may include at least one heat pipe **270**, **280** coupling the first and second sides thereof. Heat generating element **240** may include: at least one light emitting diode **242**, **246**; or a high power light emitting diode **242**; or an array of light emitting diodes **246**; or a high power light emitting diode **242** and an array of light emitting diodes **246**. Fluid mover **220** may include a fan **220** for moving air. Heat dissipater **200**, **200'**, **200"**, **200'"** may further comprise: a cover **230** adjacent fluid mover **220** and having openings **232** therethrough through which the fluid moved by fluid mover **220** moves; or a thermal interface **250** adjacent fluid mover **220** and defining passages through which the fluid moved by fluid mover **220** moves; or a thermal interface **250** adjacent fluid mover **220** and having a plurality of radial walls **254** defining passages through which the fluid moved by fluid mover **220** moves. The portable light **10**, **10'**, **10'"** may further comprise: a pivot connector for connecting heat dissipater **200**, **200'**, **200"**, **200'"** to the housing, wherein the head and housing are in a lantern configuration; or a thermal interface **250**, **250'** for connecting heat dissipater **200**, **200'**, **200"**, **200'"** to the housing, wherein the head and housing are in a flashlight configuration; or an articulated connection connecting heat dissipater **200**, **200'**, **200"**, **200'"** to the housing, wherein the head and housing are in an area light configuration.

A portable heat dissipater **200**, **200'**, **200"**, **200'"** may comprise: a heat sink **210**, **210'**, **210"**, **210'"** having a first side for having a heat generating element **240** thermally coupled thereto, and having a plurality of walls **211-215** extending from a second side thereof for defining a cavity and plural passages in fluid communication with the cavity; a fluid mover **220** disposed in the cavity of heat sink **210**, **210'**, **210"**, **210'"** for selectively causing a fluid to move through the cavity and the plural passages defined by the walls **211-215** of heat sink **210**, **210'**, **210"**, **210'**; and a heat generating element **240** disposed adjacent to and thermally coupled to the first side of heat sink **210**, **210'**, **210"**, **210'**. Portable heat dissipater **200**, **200'**, **200"**, **200'"** may further comprise: an electronic circuit **400** proximate heat sink **210**, **210'**, **210"**, **210'"** for controlling electrical power applied to heat generating element **240**; or an electronic circuit **400** proximate heat sink **210**, **210'**, **210"**, **210'"** for controlling operation of fluid mover **220**; or an electronic circuit **400** proximate heat sink **210**, **210'**, **210"**, **210'"** for controlling electrical power applied to heat generating element **240** and operation of fluid mover **220**. Electronic circuit **400** may control electrical power applied to heat generating element **240** or may control operation of fluid mover **220** or may control both responsive to the temperature of heat generating element **240**. Heat sink **210**, **210'**, **210"**, **210'"** may comprise a generally circular base providing the first side for having a heat generating element **240** coupled thereto, and a plurality of generally cylindrical walls **211-215** extending from the base of heat sink **210**, **210'**, **210"**, **210'"**, wherein an inner one of said cylindrical walls **211-215** defines the cavity for receiving fluid mover **220**, and wherein at least one of cylindrical walls **211-215** has openings therethrough for defining the plural passages. The heat sink **210**, **210'**, **210"**, **210'"** may comprise a base **216** providing the first side for having the light source **240**, **240'**, **240"**, **240'"** coupled thereto, an enclosing wall **211'"** extending from base **216** defining a passage and a plurality of generally radial walls **212'"** extending from at least the base **216** of heat sink **210**, **210'**, **210"**, **210'"** into the passage defined by enclosing wall **211'"** to define one or more of the plural passages adjacent base **216**, and a hollow member **1211** extending therefrom defining a cavity in fluid communication with the plural passages, wherein hollow member **1211** defines the cavity for receiving fluid mover **220**. An articulated connection **300** between heat sink **210**, **210'**, **210"**, **210'"** and hollow member **1211** and a flexible sheath **310** may enclose the articulated connection and providing a fluid passage between hollow member **1211** and heat sink **210**, **210'**, **210"**, **210'"**. Heat sink **210**, **210'**, **210"**, **210'"** may include at least one heat pipe **270**, **280** coupling the first and second sides thereof. Electronic circuit **400** may be disposed on a circuit board **244** defining a periphery of a given shape and size, and the heat sink **210**, **210'**, **210"**, **210'"** may have a recess **217** in the first side thereof, the recess having a shape and size corresponding to the given shape and size of the periphery of said circuit board **244**, and the circuit board **244** may be disposed in the recess **217**. Heat sink **210**, **210'**, **210"**, **210'"** may comprise a generally circular base providing the first side **216** for having a light source **240** or heat generating element **240** coupled thereto, and a plurality of generally cylindrical walls **211-215** extending from the base of said heat sink **210**, **210'**, **210"**, wherein an inner one **211** of the cylindrical walls **211-215** defines the cavity **211**C for receiving the fluid mover **220**, and wherein at least one **211**, **213** of the cylindrical walls **211-215** has openings **211**S, **213**S therethrough for defining the plural passages. Heat sink **210**, **210'**, **210"**, **210'"** may include at least one heat pipe **270**, **280** coupling the first and second sides thereof. Heat generating element **240** may include: at least one light emitting diode **242**, **246**; or a high power light emitting diode **242**; or an array of light emitting diodes **246**; or a high power light emitting diode **242** and an array of light emitting diodes **246**. Fluid mover **220** may include a fan **220** for moving air. Heat dissipater **200**, **200'**, **200"**, **200'"** may further comprise: a cover **230** adjacent fluid mover **220** and having openings **232** therethrough through which the fluid moved by fluid mover **220** moves; or a thermal interface **250** adjacent fluid mover **220** and defining passages through which the fluid moved by fluid mover **220** moves; or a thermal interface **250** adjacent fluid mover **220** and having a plurality of radial walls **254** defining passages through which the fluid moved by fluid mover **220** moves. The portable heat dissipater **200**, **200'**, **200"**, **200'"** may further comprise: a housing defining a cavity for receiving a source of electrical power therein; and a head connected to the housing and including heat dissipater **200**, **200'**, **200"**, **200'"** and the heat generating element; and may further comprise: a pivot connector for connecting heat dissipater **200**, **200'**, **200"**, **200'"** to the housing, wherein the head and housing are in a lantern-like configuration; or a thermal interface **250**, **250'** for connecting heat dissipater **200**, **200'**, **200"**, **200'"** to the housing, wherein the head and housing are in a flashlight-like configuration; or an articulated connection connecting heat dissipater **200**, **200'**, **200"**, **200'"** to the housing, wherein the head and housing are in an area light-like configuration.

As used herein, the term "about" means that dimensions, sizes, formulations, parameters, shapes and other quantities and characteristics are not and need not be exact, but may be approximate and/or larger or smaller, as desired, reflecting tolerances, conversion factors, rounding off, measurement error and the like, and other factors known to those of skill in the art. In general, a dimension, size, formulation, parameter, shape or other quantity or characteristic is "about" or "approximate" whether or not expressly stated to be such. It is noted that embodiments of very different sizes, shapes and dimensions may employ the described arrangements.

Although terms such as "up," "down," "left," "right," "front," "rear," "side," "top," "bottom," "forward," "backward," "under" and/or "over," may be used herein as a convenience in describing one or more embodiments and/or uses of the present arrangement, the articles described may be positioned in any desired orientation and/or may be utilized in any desired position and/or orientation. Such terms of position and/or orientation should be understood as being for convenience only, and not as limiting of the invention as claimed.

Further, what is stated as being "optimum" or "deemed optimum" may or not be a true optimum condition, but is the condition deemed to be "optimum" by virtue of its being selected in accordance with the decision rules and/or criteria defined by the applicable controlling function, e.g., for operating an LED at or near a predetermined temperature at which is operates efficiently or most efficiently.

While the present invention has been described in terms of the foregoing example embodiments, variations within the scope and spirit of the present invention as defined by the claims following will be apparent to those skilled in the art. For example, while heat sink **210** is shown has having slots **211**S in certain sections of cylindrical wall **211**, such slots may be provided in additional and/or other sections of wall **211** and/or of wall **213**, as may be deemed appropriate for obtaining a desired air flow and thermal characteristics.

Further, openings in cylindrical walls **213**, **211** may be made by drilling or boring radially inwardly through wall **213** and then through wall **211**. Still further, while slots **211**S are shown as being in segments of cylindrical wall **211** between adjacent radial wall segments **212**, slots or openings may be made at or proximate to where a radial wall **212**, **214** joins to a cylindrical wall **211**, **213**, thereby to form a fluid passage between one chamber and two adjacent chambers or between two chambers and two adjacent chambers.

While the preferred direction of flow of cooling fluid, e.g., air, through the passages of heat sink **210**, **210'**, **210"**, **210'"** is through fan **220**, **220'"** into the cavity inside wall **211**, **1211** and therefrom radially outward and axially out of heat sink **210**, **210'**, **210"**, **210'"**, the cooling fluid may be caused to flow in the opposite direction if desired.

Heat dissipater **100**, **100'**, **100"**, **100'"** may be connected to housing **20**, **20'** by different means than illustrated above, such as by a threaded engagement wherein both the heat dissipater and the housing have threads thereon arranged for engaging each other, or in a bayonet base configuration wherein one has plural radial pins that slip into "L-shaped" slots of the other similar to a bayonet base lamp. For example, one of circular walls **211**, **13**, **215** of heat dissipater **200**, **200'** could be extended higher than the others and have threads thereon that engage corresponding threads on housing **20**, **20'**.

In addition, the shape and/or location of reflector **110**, including center lens **112** and small lenses **116**, may be in a desired manner, e.g., for providing a spot or a flood of light, or something in between, and the location thereof may be adjustable relative to LEDs **242**, **246** so as to provide adjustment of the shaping of the produced light beam, in any of the lights described.

While the heat dissipater is described herein in the context of a portable light, it should be understood that the heat-generating component or components **242**, **246** from which heat is transferred to heat sink **210**, **210'**, **210"**, **210'"** may be an LED, but may also be any other heat generating component or element. Further, heat dissipater **200**, **200'**, **200"**, **200'"** may be connected to a housing in a lantern-like configuration, in a flashlight-like configuration, or in an area light-like configuration, or in another configuration, as may be desired.

While the example portable lights or devices **10**, **10'**, **10"**, **10'"** described herein may employ a battery or other energy source, e.g., a fuel cell, a photovoltaic (solar cell) source, and the like, light or device **10**, **10'**, **10"**, **10'"** may also be connected to an external source of power, e.g., by electrical wires. The external electrical source may be of any type or kind.

Each of the U.S. Provisional Applications, U.S. patent applications, U.S. patent Publications and/or U.S. patents identified herein are hereby incorporated herein by reference in their entirety.

Finally, numerical values stated are typical or example values, are not limiting values, and do not preclude substantially larger and/or substantially smaller values. Values in any given embodiment may be substantially larger and/or may be substantially smaller than the example or typical values stated.

What is claimed is:

1. A portable light heat dissipater comprising:

a heat sink having a cylindrical wall wherein a portion of the cylindrical wall defines a base, the base having first and second opposing sides, the first side being on the exterior of the cylindrical wall for having a light source thermally coupled thereto, and the second side of the base and the interior of the cylindrical wall having a plurality of walls extending inwardly therefrom interior the cylindrical wall for defining a plurality of interior axial fluid passages therethrough;

an elongated hollow tubular member defining a fluid passage therethrough;

a pivotable joint supporting said heat sink at a first end of the elongated hollow tubular member, whereby said heat sink is pivotable to different orientations relative to said elongated hollow tubular member;

a flexible sheath between the first end of said elongated hollow tubular member and said heat sink for defining a fluid passage between the fluid passage of said elongated hollow tubular member and the plurality of interior axial fluid passages of said heat sink;

a fluid mover disposed in the fluid passage of said elongated hollow tubular member near an end thereof remote from said heat sink for selectively causing a fluid to move through the fluid passages of said elongated hollow tubular member and said flexible sheath and through the plurality of interior axial fluid passages defined by the walls of said heat sink; and

a light source disposed adjacent to and thermally coupled to the first side of the base of said heat sink, whereby said light source is cooled by fluid moved by said fluid mover through the fluid passage defined by said elongated hollow tubular member, the fluid passage defined by said flexible sheath and the interior axial fluid passages defined by said heat sink.

2. The portable light heat dissipater of claim **1** further comprising:

an electronic circuit coupled to said heat sink for controlling electrical power applied to said light source; or

an electronic circuit coupled to said heat sink for controlling operation of said fluid mover; or

an electronic circuit coupled to said heat sink for controlling electrical power applied to said light source and operation of said fluid mover.

3. The portable light heat dissipater of claim **2** wherein said electronic circuit controls electrical power applied to said light source or controls operation of said fluid mover or controls both responsive to the temperature of said light source.

4. The portable light heat dissipater of claim **2** wherein the electronic circuit is disposed on a circuit board defining a periphery of a given shape and size, and wherein said heat sink has a recess in the first side thereof, the recess having a shape and size corresponding to the given shape and size of the periphery of said circuit board, and wherein said circuit board is disposed in the recess.

5. The portable light heat dissipater of claim **1** wherein said heat sink includes at least one heat pipe coupling the first side of the base thereof and at least one of the plurality of walls of the second side of the base thereof.

6. The portable light heat dissipater of claim 1 wherein said light source comprises:

a high power light emitting diode; or

an array of light emitting diodes; or

a high power light emitting diode and an array of light emitting diodes.

7. The portable light heat dissipater of claim 1 wherein said fluid mover includes a fan for moving air.

8. The portable light heat dissipater of claim 1 further comprising:

a cover adjacent said heat sink and having openings therethrough through which the fluid moved by said fluid mover moves; or

a cover adjacent said heat sink and having vents through which the fluid moved by said fluid mover moves, wherein the vents are downward facing when said heat sink is at an upward end of said elongated hollow tubular member.

9. The portable light heat dissipater of claim 1 wherein said movable joint includes an articulated joint providing at least two degrees of freedom of movement.

10. The portable light heat dissipater of claim 1 further comprising:

a source of electrical power at the end of said hollow tubular member proximate said fluid mover.

11. A portable heat dissipater comprising:

a heat sink having a cylindrical wall wherein a portion of the cylindrical wall defines a base, the base having first and second opposing sides, the first side being on the exterior of the cylindrical wall for having a heat generating element thermally coupled thereto, and the second side of the base and the interior of the cylindrical wall having a plurality of walls extending inwardly therefrom interior the cylindrical wall for defining a plurality of interior axial fluid passages therethrough;

an elongated hollow tubular member defining a fluid passage therethrough;

a pivotable joint supporting said heat sink at a first end of the elongated hollow tubular member, whereby said heat sink is pivotable to different orientations relative to said elongated hollow tubular member;

a flexible sheath between the first end of said elongated hollow tubular member and said heat sink for defining a fluid passage between the fluid passage of said elongated hollow tubular member and the plurality of interior axial fluid passages of said heat sink;

a fluid mover disposed in the fluid passage of said elongated hollow tubular member near an end thereof remote from said heat sink for selectively causing a fluid to move through the fluid passages of said elongated hollow tubular member and said flexible sheath and through the plurality of interior axial fluid passages defined by the walls of said heat sink; and

a heat generating element disposed adjacent to and thermally coupled to the first side of the base of said heat sink, whereby said heat generating element is cooled by fluid moved by said fluid mover through the fluid passage defined by said elongated hollow tubular member, the fluid passage defined by said flexible sheath and the interior axial fluid passages defined by said heat sink.

12. The portable heat dissipater of claim 11 further comprising:

an electronic circuit proximate said heat sink for controlling electrical power applied to said heat generating element; or

an electronic circuit proximate said heat sink for controlling operation of said fluid mover; or

an electronic circuit proximate said heat sink for controlling electrical power applied to said heat generating element and operation of said fluid mover.

13. The portable heat dissipater of claim 12 wherein said electronic circuit controls electrical power applied to said heat generating element or controls operation of said fluid mover or controls both responsive to the temperature of said heat generating element.

14. The portable heat dissipater of claim 12 wherein the electronic circuit is disposed on a circuit board defining a periphery of a given shape and size, and wherein said heat sink has a recess in the first side thereof, the recess having a shape and size corresponding to the given shape and size of the periphery of said circuit board, and wherein said circuit board is disposed in the recess.

15. The portable heat dissipater of claim 11 wherein said heat sink includes at least one heat pipe coupling the first side of the base thereof and at least one of the plurality of walls on the second side of the base thereof.

16. The portable heat dissipater of claim 11 wherein said heat generating element includes:

at least one light emitting diode; or

a high power light emitting diode; or

an array of light emitting diodes; or

a high power light emitting diode and an array of light emitting diodes.

17. The portable heat dissipater of claim 11 wherein said fluid mover includes a fan for moving air.

18. The portable heat dissipater of claim 11 further comprising:

a cover adjacent said heat sink and having openings therethrough through which the fluid moved by said fluid mover moves; or

a cover adjacent said heat sink and having vents through which the fluid moved by said fluid mover moves, wherein the vents are downward facing when said heat sink is at an upward end of said elongated hollow tubular member.

19. The portable heat dissipater of claim 11 wherein said movable joint includes an articulated joint providing at least two degrees of freedom of movement.

20. The portable heat dissipater of claim 11 further comprising:

a source of electrical power at the end of said hollow tubular member proximate said fluid mover.

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